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THE BAKHTIARI COUNTRY, SOUTH-WESTERN PERSIA:

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BAKHTIARI COUNTRY is that part of south-western Persia inhabited by the semi-nomadic Bakhtiari tribes. It lies between the Diz or Sehzar River on the north-west and the Karun River on the south-east. The area of this tract is about 20,000 square miles, of which 12,000 consist of rugged mountains. Luristan lies across the Diz River to the north-west, and south-east of the Karun is situated Qashqai and Kuhgalu territory. I had the opportunity of travelling in the Bakhtiari Mountains from May 1930 until June 1931, in company with Messrs. N. L. Falcon and A. H. Taitt, and a Persian gentleman, Mirza Nasrullah Khan Mustaufi. The object of the journey was to study the geology of the area for the Anglo-Persian Oil Co., Ltd., and I am indebted to Sir John Cadman, the Chairman, and the Directors of the Company for permission to make this communication. The map accompanying the paper is the result of plane-tabling by Falcon, Taitt, and myself, our sheets being adjusted to marginal points fixed astronomically by Messrs. S. Coventry and B. K. Smith, augmented by portions surveyed topographically by the Indian plane-table men, Khitabgul and Mohamed Hashim. The new work has been rounded off on the south-west by additions from published maps of the Survey of India.

The approach to Bakhtiari Country from Mohammerah, at the junction of the Karun River and the Shatt el 'Arab, is over low alluvial flats as far as the line of reddish-brown hills which extends north-west and south-east of Ahwaz. The Karun breaches this ridge and forms a cataract in so doing. To the north-east of the hills, low, slightly undulating country occurs up to the sharply marked edge of the foothills where steep, naked rocks rise from the alluvial plain. This is the south-western limit of Bakhtiari Country. Just outside it are situated the towns of Dizful, Shushtar, and Ram Hormuz, the points of contact between the Bakhtiaris and the world in the winter time.

Travelling north-eastwards from our point of entry at Dar-i-Khazinah, we traversed a series of low hills, mostly trending north-west and south-east, which although not high provide a succession of steep, stony slopes. At first

they are brown-coloured, later dull red, and are eroded into ridges separated by strips of bad lands. At Zeloi there is a small upland plain upon an area of country coloured red and white in bands, the latter being due to beds of gypsum. Thence the road descends from the Zeloi plateau gently at first, afterwards steeply, to the deep gorge of the Karun River. The crossing place, Gudar-i-Gazistan, is one of several where the tribes cross the river by *kilik*, a crude raft of inflated skins, during their annual migration. It owes its location to the occurrence of eddies which facilitate the primitive navigation. The track from the river on the northern bank rises so steeply that it is not easily surmounted by heavily laden mules before it enters into rough red-and-white-coloured country. About 4 miles beyond the river crossing the road zigzags up the steep southern flank of Kuh-i-Jesur, which is a narrow ridge of dull brown conglomerate running for many miles north-west and south-east without attaining any great height, but commanding a good view of the vast sea of lower broken hills. Both of its flanks are steep and even precipitous in many places.

A tributary of the Karun, the Ab-i-Chulbar, cuts through this ridge in an impassable gorge, but its valley to the north served as a route for our road across another stretch of low red-and-white-coloured serried country. On the eastern side of the road stands an example of an old Bakhtiari fortress or *diz*. It is a tower perched on the top of a conglomerate plateau, surrounded on all sides by cliffs, up which access can be obtained only by an artificial ladder way. Such strongholds were the retreats of tribal chiefs in days gone by, into which they could retire when defeated or sorely pressed. Supplies of food and water were always maintained in them in case of a siege. The prospect from the *diz* revealed a country ahead totally different from the low, ridged, variegated district already traversed. A smoothly arched mountain of light-grey rocks extended as far as the eye can see to the north-west, but plunged gently as a rounded prong to the south-east, around which closed a sea of low red hills similar to those behind us. The stream up which the road had been following now issued from a narrow gorge cut deeply into the mountain. After passing through this we had 2 miles of bad going over boulder-strewn terrace before reaching the blue-tiled tomb of Baba-Ahmad, standing on a terrace, about 50 feet above the stream, in the centre of a large bowl-shaped cavity in the mountain. The lip of the bowl, which is cliff-girt near the top, but has smooth, though steep, lower slopes, stands 2000 feet above the blue-tiled tomb.

Pursuing our way upstream north-eastward for 2 miles more, we found that it occupied a still narrower gorge, so narrow that one may leap across its pot-holed channel, and so inaccessible that in spite of blasting and masonry work done by the tribes in places, shod animals cannot be taken through it. Once through the gorge there is a long gentle valley filled by low red hills to which fall the northern slopes of the smooth mountain-arch we saw from the *diz*. Immediately the road has passed through this gorge it turns sharp north-west, following the course of the Ab-i-Chulbar, which, instead of occupying the centre of the valley, hugs the mountain for some miles.

If instead of following the road we climbed on to the whale-backed range, Kuh-i-Pabda, through the heart of which we have just come in the Baba-Ahmad Valley, a splendid view over the 30 to 40 miles of foothills lying between us and the plains is to be had. We found also that on reaching the highest point

of the gently rising mountain an array of abrupt yellowish-brown cliffs swept in an ellipse away from us towards the north-west. The cliffs are about 1000 feet high, and resemble those above Baba-Ahmad in size and appearance. Within the elliptical hollow thus formed gentle slopes fall away inwards for a time, and from their base a smoothly contoured dome-shaped mountain rises, forming a mound, Kuh-i-Gapi, concentric with the cliffs. They run for many miles north-westwards, bounding the picturesque opposing sierras of Khak-i-Sisi and Mirali, and then complete the oval by joining about 15 miles away to the north-west. Beyond them a whale-back, smoothly contoured mountain extends for miles to the north-west, very similar to that upon which we were standing.

After having rejoined our caravan at Chulbar on the north-eastern base of Kuh-i-Pabda, we entered the Gapi basin, which we had just spied out from above through a difficult ravine cut right through the cliffs of Mirali, by a stream course which carries no water at all except during the progress of rain-storms. Thereafter we could travel without difficulty on either the north-east or south-west flank of Gapi over an easy road on soft light grey shales. About 7 miles to the north-west, where Gapi has risen gently to its highest point as an even mound of limestone, it is cut from side to side by a small stream, which occupies a precipitous gorge 2000 feet deep. It is also trenched deeply through the sierras on either side. Following the shocking track up this stream course, we pass 4000 feet below the summit of Mirali into another great oval-shaped basin rather similar to the last. In this one Riyal is the central dome overlooked by the grand crags of Kuh-i-Aulif on the north-east and of Mirali on the south-west. The diminutive stream cuts across the Aulif and Riyal ridges, occupying a notch in each of them just as it did in Gapi and Mirali, and providing wonderful scenery by virtue of the bold relief.

The Riyal dome fell away and disappeared as we followed it north-westwards, and the Aulif range to the north-east of the track became a precipice-bounded knife-edge, from which the mountainous country ahead could be prospected. A few miles away the ridge was breached by another stream, beyond which it rose boldly to heights extending for miles farther to the north-west.

The tribal road runs north-west from Riyal to this next rivulet, Ab-i-Balut, or the "Acorn Water," and then turns sharply north-east up its valley. But before we followed it we ascended the mountain arch to the south and looked back along the Riyal Valley up to Kuh-i-Riyal. The rocks forming the southern wall of the valley at first slope southwards, but in the course of a few miles they steepen and then become vertical. Nearer still they slope northwards, so that the cliffs which faced north, overlooking the trough where we entered it under Mirali, have been replaced by a wall of rock that slopes into the valley, and the cliffs formed where this wall ends face to the south. The Ab-i-Balut valley beneath us had here become a narrow zigzagging gorge quite impassable for man or beast. Access from the foothills to the road which we are to follow entails either a 3000-foot climb from the level of the stream over the mountain in which the trail is dangerous for animals, or the following of the circuitous route through Gapi* and Riyal.

*Mr. L. Lockhart informs me that the name is probably derived from the Turki word "Gapi," which means "gate."

Going up the stream we found that it occupied a narrow but passable trench through the next mountain range, Kuh-i-Faru. It is an asymmetrical arch built out of innumerable sheets of limestone fitting upon one another like the skins of an onion. The walls of the transverse valleys are steep but not preponderantly composed of crags as they are in Gapi and Riyal, in which the mountain-making rocks are massive. The Faru range extends for many miles north-west and south-east, and is cut through by several small streams in the course of its length, and also by the Diz River, some 40 miles to the north-west.

This river divides in the heart of the mountain into its two principal branches, the River Sehzar and the River Zaliki. The former flows obliquely across the direction of the range from the north, while the latter, after having crossed perpendicularly to the trend almost to its edge suddenly turns parallel to it and cuts into the north-eastern flank of the arch, in a barren and desolate region, difficult of access.

Returning to the tribal road and following it up the course of the Ab-i-Balut, we emerged from the gully through the Faru mountain into an area of comparatively low relief, surrounded by high ranges. In this depression stands the tomb, Imam Zadeh Ahmad Fathullah, at the base of the south-eastern end of the mountain, Kuh-i-Kinisar. This is utterly different from any chain we have passed by, either in form or in colour. It stands like a gigantic canoe sculptured in light yellow, or almost white limestone, pointed at both ends, about 14 miles long, at most 2 miles across and about 2000 feet deep. Its sides are steep cliffs, and its summit is disposed to form a central depression which collects the precipitation into one drainage channel discharging through a notch in the north-eastern margin. It is mounted on a plinth-like stage with a base of soft sage-green shales and sandstones and gaudy upper layers of deep-red conglomerate with bright-yellow grit. Kuh-i-Kinisar is accessible by a difficult track which, making use of joints and landslips, picks its way from ledge to ledge, until it reaches the summit some 4000 feet above the Ab-i-Balut. The central depression is wooded and contains a deposit of red sandstone akin to that of the foothill area. Another range very similar in build and appearance lies across the Zaliki River along a continuation of the trend of Kinisar, called Kuh-i-Giriveh.

The trail from Ahmad Fathullah crosses the very broken low-lying country along the course of the stream, then leaving it to make a detour round the north-western end of the narrow dome-shaped range of Kuh-i-Taza. The stream has chosen a shorter route and cuts through the mountain in a gorge about 700 feet deep before it enters Darreh-i-Taza where the road rejoins it to journey for a spell of 4 miles south-eastwards. The Darreh-i-Taza is a valley to which the walls of the mountain arches on both sides sweep smoothly down, so that its cross-section is a regular, harmonious curve. It rises gently south-eastwards with Kuh-i-Taza on the right hand and Bard-i-Davit on the left, until about 12 miles away the prow of another great white limestone canoe, Kift-i-Asiftu, is poised symmetrically over the valley. It fills the curved depression of the valley much as the foresight of a rifle fills the backsight. In form and chromatic arrangement, as seen from the north-west, it appears similar to the end view of Kuh-i-Kinisar.

As we followed the tribal trail we left the Kift-i-Asiftu nearly 10 miles away

Kuh-i-Kazimistan from Kuh-i-Chahararu

Galleh Sandar from Tang-i-Mullah

Karun Gorge at Ganjab

Two views of Tang-i-Davit

Karun Gorge at Ganjab

Two views of Tang-i-Dacu

and entered the spectacular, straight defile of Tang-i-Davit. At its southern end, where it is entered from Darreh-i-Taza, large blocks of rock had become detached from the walls above, crashed into the chasm, and jammed. The track twists from side to side of the narrow gully around smaller blocks in a tunnel, completely roofed by the masses wedged above. So narrow is the way that the walls and floor are highly polished by the loads and hoofs of the pack animals, and by the flocks which pass through twice a year. The roof extends for only 30 or 40 yards, but the narrow part continues for 400 yards, when the valley opens out for a time. Within the ellipse of which Bard-i-Davit is the southern wall and Bard-i-Sursur the northern; another whale-backed range of dark limestone rises from a girdle of relatively low ground.

The stream we followed, a branch of the Ab-i-Balut, although now reduced to a trickle, occupies a gorge over 1000 feet deep cut through the heart of this arched range, and through Bard-i-Sursur. Having crossed this long ridge, which slopes gently to the north-east, but drops down in a series of small crags to the south-west, we left the caravan at about 5000 feet above sea-level while we made an excursion to the south-east in order to climb the arch-shaped mountain formed by the coalescing of the two ridges, Bard-i-Davit and Bard-i-Sursur. To do so our route lay up the valley south-eastwards to the source of this same tributary of the Ab-i-Balut. From the divide at 9000 feet, we took to the steep, smooth, north-eastern slope that depends from the summit of Kuh-i-Jahanbin—"an exceeding high mountain" which showeth "all the Kingdoms of the world."

As the name suggests, the prospect from this peak is splendid. To the north-east the still higher range of Kuh-i-Kainu restricted the field of vision, but the wild broken country we had traversed lay spread out before us to the south where the ranges already visited could be picked out one by one. Beyond them the bold crags which rise here and there in the foothills stood out silhouetted against the dull-brown background formed by heat haze above the dust-shrouded plains. The peak overlooks the depression between the Bard-i-Davit and Bard-i-Sursur ridges. The River Zaliki, several miles away to the north-west, some 8000 feet below, could be seen cutting across them, and in this gorge the piers of the old ruined bridges of Pul-i-Kul still exist. Farther off the ridges come together again and complete the oval. To the south-east from Jahanbin the arched range itself slopes down at about 15° until at about the height of 7000 feet, near Ainuk, the gradient diminishes to less than 5° and at the same time the arch is no longer steep-sided and sharp, but becomes very gentle and broad, forming an undulating plateau. It is as if the back of a trout had suddenly become that of a flounder. This change takes place where the character of the rock alters from the massive limestone of the east to the platey limestone of the west.

We resumed our interrupted journey and followed up the zigzag track across limestone screes to the 9000-foot pass of Silili, which separates the high grazing country from the low barren valleys. From Gapi to Silili the tribes have to move comparatively fast as it is stoney inhospitable country where there is little grass at any time of year. North of the pass the alps are usually much higher and covered with snow for some time during the winter. Where these conditions obtain abundant pasture is found soon after the snow melts.

Silili is one of the narrow prongs into which the great broad-backed mountain Kuh-i-Kainu divides at its north-western end, where the underlying rock changes from massive to platey limestone. The mountain runs as a continuous range from the Zaliki River to the Karun River, and only in a few places can tribal tracks cross it. No stream cuts across its whole width between these two rivers, and it remains a bold, simple arch feature for most of its course. The north-western prongs plunge to the River Zaliki, which cuts across their ends. At Tembi a shallow lake has formed at the foot of the cliffs of Kuh-i-Kainu. It is debris blocked; the situation is ideal for a glacial lake, as the steep cliffs rise corrie-like to south-east and south-west, but all signs of glaciation are missing. I attribute the dam to a former landslide, and the cliffs to normal erosion of a minor wrinkle.

From Silili the comparatively low ground across the River Zaliki extending to the mountains beyond Sar-i-Kul is displayed. Ridges of light-coloured rock run north-west to south-east separated from one another by areas of sage-green bad-lands. Beyond the lowland two conspicuous mountains can be seen each with an undulating plateau-like top. White cliffs circumscribe them and give way below to yellow and red layers resting upon a basement of sage green. A similar colour scheme, running as far as the eye can see, bounds the lower ground as a rampart on the north-east.

A steep descent over the prong-shaped end of Kainu took us to the River Zaliki, where it changes from a downstream direction of east–west to an upstream course of nearly north–south. We saw it entering a deep gorge through Kuh-i-Lanadru, which our road crossed at over 9000 feet after a two-days' journey, at first south-east to Libd along the foot of the grand north-eastern slopes of Kuh-i-Kainu, and then north-east from Libd to Lanadru across broken, rugged country.

Lanadru is the second of the high passes on the Chahar Lang main road. The Chahar Lang is the smaller of the two great septs of the Bakhtiari Clan, and now occupies the mountains between the Karun-Zaliki divide and the River Zaliki. The greater sept, the Haft Lang, occupies the basin of the Karun River. From Lanadru we had a choice of routes, and before proceeding we could easily surmount from here the heights of Bard-i-Gap. Bard-i-Gap is a clump of conglomerate mountains which, although only lying a few miles from the River Zaliki, form part of the divide between the Zaliki and Karun Rivers. The north-west and south-east orientation of its ridges is maintained, just as in the other mountains, and there are cliffs facing north-east and south-west in places. From a summit of about 11,000 feet they fall away eastwards to the rolling hills which rise within the valley of the River Bazuft, one of the main tributaries of the Karun, on its right bank.

As we looked down the Bazuft Valley we saw Kuh-i-Kainu's slopes forming the south-western side and the triple rank of cliffs fronting Zardeh Kuh for about 50 miles, making the north-eastern side of this valley. From this precipitous front the range of Zardeh Kuh falls away in regular slopes north-eastward. Along its length from the River Zaliki to the Karun near Ardal several fine peaks rise up, of which the most spectacular is the rugged pyramid of Haft Darun. The range is quite asymmetrical. Cliffs face south while slopes fall to the north. No mirror images with a trough separating them are to be

found here, as for instance Bard-i-Davit and Bard-i-Sursur. The colours in this chain are varied. The olive-green, gentle, lower slopes are surmounted by the first precipice which is almost black in colour. Above it lies a terrace, like the tread of a step, coloured khaki and light grey, sloping up gradually to the second step coloured dark grey. This has a light-grey platform upon it which leads up to the third, the highest and most impressive rock-wall, in which tones of browns and reddish-browns are common. The principal peaks all occur carved out of this dominating mass of rock, and in places rise to over 14,000 feet.

The drainage collecting upon the platforms has escaped by gouging deep gullies through the hard rocks of the cliffs. Hard-packed snow, shaded from the full force of the sun, now lies in these during most of the year. In the narrow gashes which have been incised on the northern slopes snow accumulates still more readily and lies longer. The principal high pass, Gil-i-Shah, leads across the range to a descent over a long glissade of snow on the northern side.

Our road however keeps to the west of Bard-i-Gap and falls from about 9000 feet at Lanadru to a little over 4000 feet at Pul-i-Zirk in the next stage. On the way, in Darreh Ti, we encountered the first of those strange "eczemas," or salt-domes, which are so numerous in southern Persia. The area is one of confused, low, terra-cotta-coloured hills, with typical bad-land topography. Rising above these pink-tinted disorderly mounds are precipice-bounded black hills formed by isolated blocks of limestone as much as 500 feet high, and a quarter of a mile in diameter. The variegation is increased by the glistening white salt crystallized in small salt-pans, fed by the springs which issue in the neighbourhood.

Immediately beyond Darreh Ti the road crosses the end of Zardeh Kuh, which has now dwindled to a low ridge on account of the rock which forms the third prominent line of cliffs to the south-east, having changed from massive to less robust platey limestone. The River Zirk is crossed at Pul-i-Zirk by a small native bridge built of a wattle mattress resting upon stout poles. A serviceable pier has been found by taking advantage of a large boulder which happens to lie in a narrow part of the torrent bed. The river rises on the northern slopes of Zardeh Kuh, along the base of which it flows until it joins the River Zaliki about 4 miles below Pul-i-Zirk. Another range, shaped like a saw-tooth, rises and forms the north-eastern wall of its narrow steep valley. The road divides at the bridge, the main route following along the course of the River Zirk, but we took the lesser track which, making use of a break in the cliffs north of the river, rises to Chin-i-Kiwar. After a climb of over 2000 feet we arrived at a spring on a small plateau, and from a camp established here visited the hilltop to the south-east from which the country around can be seen.

The north-west, south-east grain of the country continues to be its controlling feature, but we observed that the ranges to the south-east are narrower and less bold than they were, although a group of closely packed ridges to the east rise into considerable peaks, in a clump of mountains known to the Haft Lang tribes as Kuh-i-Rang. To the west the continuation of the ridge passed at Lanadru is very prominent, and runs boldly north-west as Kuh-i-Galili. North-west of us lies the high mountain system of Qal'eh Kuh composed of

several wrinkles expressed as domes and troughs, broken across by lines marked with cliffs where disturbances have ruptured this tortured zone of the Earth's crust. The scenery is superb, the going arduous.

Between us and this range lies the Zaliki River, deep in a precipitous gorge orientated north and south. Where the gorge ends at Baznui the river comes into view for a reach at the foot of a long slope down from Chin-i-Kiwar, and under cliffs on the far side until it suddenly turns north again to pass through this cliff-bounded ridge in a narrow gorge. The route from Chin-i-Kiwar spring led us gently upwards to a divide from which we looked into a gully, no longer grey or brown coloured, but deep red, and after passing another spring just about the junction of the two colours we trekked over a narrow divide of red sandstone to the green and dark rocks which form the pavement of the long gentle slope down to the river at Baznui. There are the ruins of an old bridge at this place, already described by Major Sawyer, but now a flimsy pole-and-wattle bridge is all that exists, and this is removed whenever it suits the economic or tactical requirements of the tribes.

From Baznui the abrupt change in direction of the river is very clear. It flows towards the few flat-topped huts beside the terraced rice-fields, which is all that there is of Baznui, along the grain of the country from the south-east, and away from them due south, through the impressive gorge, we could see from the heights of Chin-i-Kiwar cutting across the grain.

The road leading northwards rises 3000 feet from Baznui to the top of a narrow ridge, Ru-yi-zard, running south-eastward from the base of the black looming cliffs at the eastern end of Qal'eh Kuh, and as we breasted it we saw the river before us, ensconced in a gorge below. Across the ridge from river to river is only about 2 miles, and yet the river flows on the north-eastern side of Ru-yi-zard for 12 miles south-eastwards before breaking through this narrow barrier in the gorge we saw north of Chin-i-Kiwar. At the extremity of this hairpin bend the river receives from the south-east a large tributary, the River Gukun, which maintains its regular course at the southern foot of the Vanizan range for a considerable distance.

From our station above the river on the ridge we looked along the front of the Vanizan range south-eastwards and observed that it rises to a summit some miles away in that direction. Several parallel lines of crags, of which those forming the wall of the gorge are by far the finest and highest, occur between the hilltop and the river. From the summit north-westwards the range tails off gradually in height and width, and just north of us, where it has dwindled to a prong only 8200 feet above sea-level, but before it gradually rises again to the end of Qal'eh Kuh the river has entrenched itself in a narrow gorge 2000 feet deep, cut irregularly across. The road also makes for this earlier col, which it crosses near the lip of the river's gorge.

The scene north of this col is very different from what lies southwards. The river far below lies in a deep-red valley, with walls cut from old gravel terraces. For some miles we looked across an extent of plain, formed by the flat-topped remnants of an extensive gravel deposit. It appears as though a considerable lake had extended from the col northwards to the foot of Ushtarinan* Kuh, and

*Ushtarinan is a variant of Shuturinan, meaning "camels." The mountain has several humps along its crest.

eastwards to Gallizan, whilst away south-eastwards we saw relics of the old lake deposit on the northern flanks of Kuh-i-Vanizan. Above the level of this plain a few stacks of rock protrude, and the four mountain ranges against which it abuts all rise ruggedly from the plateau-level upwards. The tributaries of the river have cut deeply, but the many relics they have left, and the sections they afford through the thick gravel beds, leave no doubt about the former extent or origin of the sheet.

Our road onwards led over this plateau, past Qal'eh Pachah to the north, and at length passed off the gravel terraces on to the gentle hills beyond. Now we had reached the edge of the Central Plateau of Persia. Mountains still rose before us, but they are no longer closely packed, and have between the ranges wide belts of gently undulating country. For a few miles the drainage, accommodated in open valleys, still feeds into the Ab-i-Zaliki which falls into the Persian Gulf, but a little farther on the streams flow north-eastwards, and make their way into the central depression of Persia to lose themselves in the salt wastes of the interior. Here we find abundant villages, the first to be encountered since leaving the plains. Within the mountains only occasionally a few flat-topped hovels nestle in a valley, sufficient to accommodate at most a few people and their scanty flocks during the rigours of winter. In that region the population is migratory and dwells in mobile black woollen tents; in this it is settled. Transport also changes here, for a car can be taken almost anywhere in the plateau region, only the numbers of *jubes* or irrigation trenches causing minor irritating delays away from the principal trunk roads. We left in the mountains thirteen of our mules who paid toll with their lives to the difficulties of the way where no car can venture.

Before returning to the lowlands by another route we briefly explored the attractive country around Qal'eh Kuh and Ushtarinan Kuh. Between them lies a deep valley from which moderately steep slopes lead up to the crags on the southern face of Ushtarinan Kuh. At first the drainage is eastward through the plateau of Qal'eh Pachah, but after two days' journey we left this and reached the tributaries flowing north-westward to the River Sehzar. The valley narrows here, and two great scars mark the face of Ushtarinan Kuh, testifying that major landslides have occurred. The first is very fresh and cleanly scoured, but the second shows the signs of greater antiquity, being not less than half a century old, whilst the other dates back about fifteen years. The piles of debris from these rock-falls have effectively dammed the valley so that behind each of them a lake is found, long by comparison with its breadth. The lower is the larger, about $1\frac{1}{2}$ miles long. This picturesque lake lies under the crags of naked, blue-grey rock towering nigh upon 6000 feet over it. When seen from above, its waters, fed by the melting snows, form a pleasing picture in greens and blues. They debouch north-westwards through a fringe of rushes into a valley with a gorge below. This is Galleh Gahar, the Lake Irene of Col. Sawyer,* a treasure lying hidden within these magnificent Iranian Hills.

Returning again to Qal'eh Pachah to begin our journey back to the plains, we set out south-eastward with the black cliffs of Gallizan on our left and the slopes of Vanizan on our right. After about three hours' journey from the River Zaliki we reached the top of the Qal'eh Pachah plateau again and

*Lt.-Col. H. A. Sawyer, *Geogr. Journal*, 1894, vol. 4, p. 491.

looked back over the old lake site. Looking ahead up a broad, red-tinged valley a remarkable notch in the side of Kuh-i-Vanizan arrests the eye. Below it the mountain slopes smoothly and steeply downwards, but above, the slopes have been fretted into valleys and are rough and irregular. This notch, we found, extends nearly as far as Masir, 16 miles ahead, keeping at an approximately constant level on the mountain side, somewhat higher than the plateau height at Qal'eh Pachah. Apparently the valley was filled with water or gravel which protected the lower slopes of the mountain whilst the higher ones suffered erosion. If this part of the old lake has been terrace filled, the deposited materials have already been removed. The drainage here is peculiar. A considerable stream breaks through a deep gorge in Gallizan, cuts diagonally across the wide-open valley, and enters the flank of Vanizan, where it occupies a deep gorge parallel to the trend of the range until it joins the River Zaliki just below the col above Baznui.

As we fared south-eastward the small stream we had been following for a few miles to Masir, a mere brook, left the wide valley between Gallizan and Vanizan and cut in a gorge across the Vanizan range which had declined to a col about 9000 feet above sea-level. After crossing a spur east of Masir we descend to the Zimistani stream from the south-east as it leaves the broad trough between the two mountain ranges to enter a narrow deep defile incised across Vanizan. From here the range is known as Chahardah Pali, and the one on our left as Kuh-i-Shahan. The former is an even, rounded, regular swelling, whilst the other is a rank of isolated piles of black forbidding crags, a platoon of spear-heads reared to the sky. On both sides these mountains rise above 14,000 feet, and the divide in the valley between them reaches 10,000 feet. A few miles more beyond this watershed and we come to the Gakun stream, which, with scant respect for either range, cuts from north-east to south-west until it reaches its more regular course in front of the Chahardah Pali–Vanizan range, to flow north-west and join the River Zaliki.

This obvious and easy route we had been following continues to the south-east, and we re-visited it later, but now we forsook the easy for the hard and struck over the Chahardah Pali range to Sehpulan lying amid the congested ridges we had seen to the east from Chin-i-Kiwar. From Sehpulan we followed a narrow valley south-east towards Niyakan, but about halfway we came to the divide, less than 3000 feet above which are two peaks in the clump of mountains known as Kuh-i-Rang. Scaling the one on the right of the track we commanded a view of a triple watershed. North-westwards wild, steep, difficult country extended within the drainage of the River Zaliki; eastwards is the basin of the Zaindeh Rud. South-westwards, rising on the flanks of Zardeh Kuh and Kuh-i-Rang, the Karun River lay below us, flowing south-eastwards in a terraced valley at the foot of the northern slopes of Zardeh Kuh. The mildness of the scenery eastward and southward is striking in comparison with that of the rugged region to the west. The narrow troughs between ranges in the west give place to wider intervals eastwards, and the ranges are more massive, if fewer in numbers.

Niyakan lies at the edge of the plain where the Chahardah Pali range dies out and the River Zaindeh Rud meanders across it to the foot of the Shahan range through which it cuts in a gorge before reaching the Central Plateau

proper, on its way to Isfahan and the deserts beyond. The basin of the Zaindeh Rud is narrowly restricted in this area, which indeed seems to belong normally to the Karun drainage. Within it one conical red mountain rises, which both on account of colour and shape is noteworthy in this region of sombre, orientated ranges. It is named, as one would expect, Kuh-i-Surkh, the Red Mountain. Into the north-western side of this plain many ridges plunge, but on the south-eastern side only one takes its way. We found that the limestone forming the upper part of these mountains is massive, while north-west from whence we have come it is limestone, not massive, but arranged in many thin layers.

The continuation of the Shahan range runs on for many miles south-east, and although it boasts several peaks, none are so bold or abrupt as the peak of Kuh-i-Shahan itself. This range limits the Bakhtiari Country for 180 miles on its landward side, and divides strikingly different types of country. To the south-west lies a welter of high mountains, all roughly parallel, deeply dissected and rugged, having only rare and limited patches of plains between them. To the north-east the bulk of the country is gently undulating with extensive plains, and only here and there mountain ridges, and while each individual ridge maintains a regular longitudinal trend-line they seem to be scattered about without much respect for neighbouring ranges.

After leaving Niyakan we went southward across a ridge at Karkunan where a Persian monarch unsuccessfully attempted to interfere with the dispositions of nature by cutting a canal from the Karun to the Zaindeh Rud to swell the volume of the latter so as to water his capital of Isfahan the better. We entered the upper valley of the Karun, where a terrace about 300 feet above the river marks the level of an old obstacle. On the southern flank the great spring of Chashmeh Kurang* provides by itself the source of a fair-sized stream which joins the main one below Karkunan. As far as Ardal it flows between the north-eastern slopes of Zardeh Kuh and the cliffs of Kuh-i-Zarrau, or Kuh-i-Zirreh, as it is called farther south-east, often in a fairly expansive valley. At one place only a dome-shaped mountain rises in this tract to block the valley, but the river has ignored it completely and makes no attempt to deflect its course but cuts a deep narrow gorge through the obstruction in pursuance of its south-eastward journeying. A tributary from the north-east joins the Karun near Ardal after a dark passage through Tang-i-Darkash Warkash, a deep gorge cut from side to side of the Zirreh range. Here, as at Qal'eh Pachah, an area of gravel plateau marks the site of a filled-in lake. The Sabzu stream from the south-east, instead of joining forces before the Karun leaves this old lake basin, cuts a gorge for itself through the southern rock margin, and joins the Karun at Dupulan. Below this village, after the Karun has received other tributaries from the west, the river rushes into a tremendous gorge confined on the left hand by the great cliffs of the Kuh-i-Hazar and on the other by the slopes of Kuh-i-Bazman. The Karun continues along this course to Ganjab, where it is joined by the Ab-i-Wanak, which, flowing from the south-east, has chosen an analogous bed below the cliffs of Hazar Kuh and the slopes of the next range to the south-west, Kuh-i-Abbagh. This gorge is the profoundest in Bakhtiari Land, as for a time it is walled by 8000-foot cliffs on the north and by 7000-foot rock slopes on the south.

*See Mrs. I. L. Bishop, 'Journeys in Persia and Kurdistan,' 1891.

From the Ardal plain we travelled eastward over the end of the dark crags of Kuh-i-Kalar, whence we overlooked northwards the plain of Chighakhur. In a swamp and lake at Chighakhur another branch of the Karun, the River Wanak, rises and flows east to the lake of Ganduman, pleasantly situated by a copious spring at the foot of the continuation of the Shahan range. Thence the river skirts the eastern end of Kuh-i-Kalar truncated at a north-south line of cliffs, and rounds the two-crested, dome-shaped hill known as Kuh-i-Dudalu, the "Hill of the Two Old Women," to flow southwards along an erratic course to Wanak. It cuts through the present conglomerate hills as though they did not exist, and forsakes what appears to be an easy route for a more difficult one. Having reached the latitude of Wanak it suddenly bears west below the cliffs of Kuh-i-Dalan, and shortly afterwards doubles back under the crags of the Bard-i-Nizami to the foot of Kuh-i-Hazar, where it flows north-west to join the Karun at Ganjab.

The shoulder of Kuh-i-Dalan provides an excellent vantage point from which to spy out the land to the south and west. Below us the fertile, rice-growing plain of Falat is spread out, bordered on the east by a long line of dark cliffs, and continuing until it is cut off by the Khirsin River as it flows west from the back (north-east) of Kuh-i-Dinar. West of us lies the wide plain of Khaneh-Mirza, and beyond it are arranged the smooth whale-backed ranges extending to the edge of Kuhgalu. From this very point we could see in that inhospitable and, until recently, insecure district many wooded ranges trending north-west and south-east under the greater eminence of Kuh-i-Dinar.

From Kuh-i-Dalan our road lay across the northern end of the Falat Plain and Khaneh Mirza Plain, upon which several small villages are situated. The route then follows the comparatively wide valley between two whale-back mountains, Kuh-i-Abbagh on the right and Kuh-i-Kalar-Janaki on the left. After two days' journey we reached Ganjab, where the Karun River breaks from its trend-gorge and makes a sally south-westwards. The point it has chosen to break through is the one where the plunging ends of the Abbagh and Bazman mountains are pierced by a circular dome-shaped hill of gypsum, clays, and salt. The top of this stands at about 6000 feet above sea-level, a height at which the river seems to have been flowing at one time. For many miles south-westwards the river swings in minor sinuosities on its way to Bars, cutting through ridge after ridge of young conglomerate, and one wide fold, the ultimate south-eastern extension of Kuh-i-Kainu, here known as Kuh-i-Safid. Within its gorge through the Kuh-i-Safid the Karun is joined on its right bank by the River Bazuft near the crestal part of the arch. The Bazuft River has been content with a course along the foot of the northern flank of Kuh-i-Safid as far as Pul-i-Amarat, but just below it has occupied a breach in the mountain side and joins the Karun after a short reach along the very axis of the mountain arch.

This strange behaviour can be explained if we picture the country less folded or filled in up to the level of a col in the Kuh-i-Safid, *i.e.* to a height of nearly 3000 feet above the present river-level. At this height the earlier Karun must have flowed towards the col, while its tributary, the Bazuft, hugged the nose of the mountain at that time as it still does the present flank in many places upstream. Thus it once joined the Karun at the old col. As the main

Kuh-i-Mirkhushk

Lower bridge at Pul-i-Kul

Kuh-i-Kinisar from the north-west

Tombs at Darreh Duzdun

Galleh Gahar (Lake Irene)

river dug down into the heart of the range with the passage of time a gorge would be formed, and because the main stream cuts faster than its tributaries the tributary Bazuft would have to hasten its cutting action near its mouth and cut this downwards as the Karun entrenched itself. Resulting from this action the river finds itself now about 3000 feet vertically below the course it occupied when it had adapted itself to the surface configuration before the gorge through the Kuh-i-Safid had been excavated by the Karun River. This, then, is a case of incised or superimposed drainage. The cause may have been rejuvenation by uplift, or by tightening of the fold. The behaviour of the river at Darkash Warkash, at Ardal, at Wanak, and at many other places, and of the little brooks at Gapi and Riyal, can be explained by the supposition that the drainage was initiated when the relief was less and the river system stood about 3000 feet above the present river-level.

Immediately below the junction of the Karun and the Bazuft the Lurdagan River from Khaneh Mirza enters the Karun, and at Bars, across a broad valley filled with red-coloured soft sands and shales, the Khirsin River, the largest tributary of the Karun, enters from the east. This river serves as a natural boundary between the Bakhtiari Country and Kuhgalu, and maintains a roughly westerly course from its source behind Kuh-i-Dinar to Bars. It passes on its way through numerous rocky chasms scored deep into the heart of many mountains.

The Karun near Bars laps against the northern base of Kuh-i-Mangasht, in deference to which it turns north-west and follows the grain of the country until it has passed beyond the sphere of influence of that fine whale-backed range. Although pursuing a general course along the grain of the country the river zigzags, cutting backwards and forwards across ridges, which form mountains of 2000–3000 feet elevation above the river, but are minor features compared with the main ranges we had traversed. Terraces are common, and they are preserved at different levels above the river. They are particularly well developed at Susan, where it enters a fine gorge cut 3000 feet into the heart of Kuh-i-Landar, and on emerging through the cliffs of Kuh-i-Gazir.

About here the Shimbar River, rising at the foot of Kuh-i-Jahanbin, pays its tribute, and the Karun again turns south-west, cutting through Kuh-i-Bilawan and Bard-i-Qamchi in two deep defiles, although in the latter case it seems as if an easier course might have been available round the end of the mountain. The top of the walls of this gorge is at approximately the same height as the plain at Malamir. This old historical plain, near which Layard* found cuneiform inscriptions, is probably linked up with the filling-in of an old basin caused by the growth of such an impediment in the Karun drainage system as the Bilawan or Bard-i-Qamchi mountains.

Our route from Bars to Bard-i-Qamchi to view the river at many points had been rocky and difficult, but from Bard-i-Qamchi onwards the trail picks its way over low red sandstone or white gypsum ridges above the left bank of the Karun to Zeloi. The course of the river continues to be incised in a twisting gorge which eventually emerges on the edge of the plains above Shushtar.

As a result of the journey we found that it is possible to distinguish in Bakhtiari Country three major divisions—the foothills, the mountains, and the

*Sir A. H. Layard, 'Early Adventures,' 1894.

high inland plateau. The foothills zone is a strip in which straggling ranks of low serrate ridges, red, grey, and white in colour, are interspersed with and overlooked by steep ranges bounded by unscalable walls of conglomerate. North-eastwards lies the mountainous area. In the south-western part of this the country has been thrown into well-moulded arches and troughs from which erosion has carved valleys of simple secondary type or left mountains upstanding. It is a region of rugged relief and of many bold features expressive of the underlying structure, and of mellow tints which vary from cream-colour through shades of yellow and buff to dark greys and browns, according to the hue of the nearly naked rock formation. Rivers and streams cross the crustal wrinkles normally or diagonally, and in places flow parallel to them. The drainage flows off through tortuous cliff-bounded cañons which have added random complications to the simple pattern of parallel arches and troughs that first resulted from folding.

A change in the composition of the main mountain-building limestone takes place from north to south. In the north this rock is built up of very many thin beds; in the south of fewer thick ones. North-westwards sharp-backed, less persistent but more numerous ridges are the prevailing features; south-eastwards a limited number of bold open arches dominate the landscape.

In the north-eastern strip of the mountain country many imbrics are included. When an arch of rock breaks and one side moves across the trough which lies on each side of every normal mountain arch, a hill is formed in which there is but one escarpment and dip-slope feature. Such breaking and telescoping of the geological structures which underlie and determine landscape-forms may be accomplished by a multiplicity of breaks and thrusts instead of by the single rupture mentioned above. A structure affected by a succession of parallel break and thrusts is described by geologists as imbricate, because it consists of a number of slices of rock which overlap one another like tiles on a roof. Any individual slice in such a structure may be called an imbric.

In this subdivision of the area the imbrics are usually bounded by cliffs on the south-western side, but the land forms behind are often complicated on account of corrugation of the north-eastern limb. Where the controlling limestone is preserved in massive condition, the shape of the imbric is usually simple, but where this is platey or absent wrinkles are abundant. Where crumpling has been most intense the northern limb has broken so that precipices bound the imbric on the northern side also.

The trend valleys in this strip are often followed by a river which is overlooked on the one side by cliffs and by dip-slope surfaces on the other. Crossing the grain of the country from one trend-valley to another, the rivers occupy wild, crooked gorges which appear to owe their alignment to chance. Lake deposits, gravel terraces, or conglomerate masses cover the floor of the troughs in places. Elsewhere they are blocked by landslide material and the lakes these obstructions have impounded. In other instances the troughs are bare, swept by the combined agents of erosion.

Within the limits of the mountain zone there are a few small areas of pink-coloured, bad-land topography due to the appearance of salt-domes at the surface. These are sharply limited in extent, and are utterly foreign in colour and form to the scenery around them.

The third division, the high Central Plateau, has a disturbed margin which may be divided up into a trough zone with minor hills of light-coloured limestone perched on a base of red chert, and a high mountain range zone composed of a species of imbric. Beyond this, mountains rise up here and there in a region of comparatively low relief.

Most of the rivers rising about the edge of the Central Plateau flow south-westwards, breaking through many ranges on their way to the coast. They occupy deep crooked gorges through the mountains, and tributaries join at surprising points. It seems as if the drainage had been initiated when the country was less folded and tilted south-westward, and as the folds increased in intensity the rivers cut their valleys down along the previously determined routes. Cross fractures have not, in general, been followed by rivers; but trend faults are often used for their valley-ways.

Tang is the Persian word meaning a gully. Loftus* described tangs and attributed their formation to "the tension of the cooling mass at right-angles to the axis of the chain in which they occur." Many a tang is nothing more than a gully on a hillside, merely a water-formed valley of high relief. The valleys Loftus appears to have had in mind are such as are found along the Karun, where it appears to cross structures haphazard instead of following the trough. As already described I attribute these tangs to superposition of the present drainage on an earlier one.

The rare cases, of which Tang-i-Davit is an excellent example, are characterized by their direct, straight passage through a mountain side. In Tang-i-Davit this is not due to faulting, as the two sides of the narrow cleft have not moved relatively to each other. The Tang floor is covered with gravel. The wall-rock is weather-sculptured, massive limestone standing in almost vertical beds. The cause of this feature is at least a master-joint and at most a gaping fissure which has controlled the course of water erosion.

In the foregoing description of a journey through Bakhtiari Country and in the conclusions based upon it I have discussed briefly only one of the many aspects of the geography of the region. The people, their habits, history, and folk-lore, the fauna and flora, the rocks, and the archaeology all await the further work of specialists.

DISCUSSION

Before the paper the President (Admiral Sir WILLIAM GOODENOUGH) said: The more recent history of the Bakhtiari country of which we are to hear to-night is a very interesting one. Those interested in what our lecturer is to tell us to-night, namely, the search for oil, have found a very virile race in their searchings through the Bakhtiari country. He will tell us to-night both of the country and of the people. When I mentioned this morning to some one that our lecture was to be on the Bakhtiari country he at once asked me—and I was not surprised—whether that was the place where the camels came from. I said that it was not, but I confess that I was very glad to look it up and find that I was right, because I do not know very much about the Bakhtiari country, and there may be others here who are in the same position. But I did tell my friend that although that ancient form of transport did not come from Bakhtiari, another modern form of transport—or,

*W. K. Loftus, *Quart. Journ. Geol. Soc.*, vol. 11, 1855, p. 247.

at least, the spirit of it—did come from that region; namely, the transport in which oil is the motive power.

Dr. Harrison, who lectures to us to-night, is English by birth, a geologist by profession, and an explorer by preference. That makes a most admirable combination. He has travelled all over the world in quest of fuel for the Anglo-Persian Oil Company. It is interesting to note how travellers get together. One of his companions on his travels in the Bakhtiari expedition, Mr. Falcon, accompanied a very different expedition, namely, Mr. Watkins's first expedition to Edge Island.

Dr. Harrison then read the paper printed above, and a discussion followed.

The PRESIDENT: I will call first upon Professor Gregory, who combines his geology and his geography in so charming a way that he is always welcome on this platform.

Professor GREGORY: I have only to mention that Dr. Harrison was a student of mine in Glasgow for the Society to understand the pride and pleasure with which I have listened to his lecture and admired his clear diagrams and very beautiful illustrations and photographs, which have given us a most realistic impression of this rough and difficult country. It brings back to me the striking contrast between the intimate knowledge of this area displayed by Dr. Harrison and the little that was known of it twenty years ago when I was trying to understand the relations of these mountains to those of the Alpine and Himalayan system. That study led to my being asked to write the Admiralty Manual on Mesopotamia which was issued early in the war.

The area includes several features of great interest. One of them was the nature of the narrow valleys, or *tangs*, of which Dr. Harrison showed us such graphic representations. Attention was called to them by Loftus in 1855, and he suggested that these valleys could not have been fashioned by the ordinary forces, wind and rain and rivers, but that they must have been due to the ground being torn asunder; in a word, that they were tectonic in origin and due to direct Earth movements. That view, which Loftus supported by some strong arguments, was accepted by Lord Curzon in 1902, and later by Sir Arnold Wilson. In writing about these tangs I suggested that the evidence brought forward by Loftus, although striking, was not yet sufficient to prove the nature of the tangs; that evidence is now available owing to the detailed study of this country by Dr. Harrison and his colleagues.

Dr. Harrison has kept off theoretical questions to-night. He might have referred not only to the tangs but to many features of academic interest. I will follow his example, and not attempt to discuss any of these problems. I will only express gratification that the detailed surveys by the Anglo-Persian Oil Company should have again been proved—as so often before—to be not only of great practical value but of great theoretical interest. We express our gratitude to Dr. Harrison for having made such magnificent use of his opportunities and for making such valuable contributions, not only to the geography of South-West Asia, but to the same fundamental problems of physical geography.

The PRESIDENT: It would be an impertinence on my part to introduce to this audience Sir Arnold Wilson. I have only to mention his name and ask him to address you.

Sir ARNOLD WILSON: After the words of praise that have fallen from Professor Gregory's lips it is unnecessary for me to offer further comments on the extraordinarily lucid and interesting lecture which we have heard from Dr. Harrison. His difficulty has been that he has only had an hour, whereas three or four hours would be necessary in order to give an adequate idea of other aspects of this

country which really interest him as much as those he has brought before us. He has spoken of imbrics and tectonics, but there are many other matters of interest which he had to pass over.

It is a country which, in the pictures we have seen, which were taken in February, appears to the eye as intrinsically abominable and vile. But that is really a false impression. Now January, February, and March do not show England at its best, nor, for that matter, the Bakhtiari country; and I, who have spent many pleasant years in or near the Bakhtiari country, am bound to explain that the mountainous country, over a part of which we have been taken this evening, is occupied by a population of some 250,000. The inhabitants are a virile race; the men, as Dr. Harrison's photographs show, are strong and big-boned, with a will of their own, and with a tendency, not unknown even in the City of London, to appropriate, shall we say, unearned increment due to the carelessness of others! Dr. Harrison has referred to Lurs, on the authority of Lord Curzon, as thieves. Lord Curzon said that "Lur" means thief, a statement for which there was no philological foundation. We all know that nursery rhyme about Taffy, and Taffy, as we now know, does not mean a thief. The real drawback of the Bakhtiari country is that there are not enough sheep to go round. If there were enough sheep there would not be any of these unfortunate complaints about the loss of sheep by individual owners.

The country is, in the spring and summer season, one of the most beautiful parts of the world that I know. As Dr. Harrison told you, the people live a purely nomadic life. Their flocks, totalling some five million sheep and goats, live in the winter and early spring in the lowlands. Those hills, which appeared so barren in the photographs, become brilliantly green in the spring, and as the weeks pass the flocks gradually work north, crossing the rivers, and moving up month by month, doing about 1000 feet every fortnight, until they finally come to rest at from 7000 to 9000 feet. This gives the flocks fresh grass for some five months of the year, and such is the fertility induced by this extraordinarily luxurious diet, that sheep generally drop lambs twice a year.

The people, although they are rude and unlettered, are not unlearned. They are very good storytellers, and Mr. and Mrs. Lorimer have placed on record, in a book which I may commend to you, a delightful series of folk tales taken down from the lips of the Bakhtiari people. Layard's book, 'Early Adventures in Persia,' published in 1887, is one of the most delightful books I have ever read. It deals with his adventures in the forties. The lecturer has mentioned Lake Irene, named, according to Major Sawyer's own account, because the lake appeared to be, like his little daughter, "also of a placid disposition." I hope the name will remain on the maps, if only in brackets. Major Sawyer was sent out by the Government of India in 1889 to examine the whole Zagros Range, and ascertain what opportunities there were for the making of roads on the one hand and for defence against Russia on the other. Other travellers who have left a record of their journeys in the Bakhtiari Country are Stocqueler, who passed through the Kuhgilu country, Baron de Bode, Colonel Mark Bell, V.C., Lady Durand, Captains Lorimer and Ranking, Mrs. Bishop (who wrote two admirable volumes), and a lady named Doctor Maclean Ross. A Frenchman, M. Guillaume, has produced four monumental and finely illustrated volumes, which vie with the sumptuous productions of Jacques de Morgan. Nor must we forget the Spanish diplomat, Rivadeneyra, in the eighties.

Of the flora and fauna we have seen very little this evening. Zaruduy, a Russian ornithologist passing through the Bakhtiari country in the early years of the present century, has recorded a remarkably wide range of bird life. Major Sawyer found a large number of plants which, as recorded in his book, were sent

to the gardens of Kew. On the anthropological side comparatively little has been done, but it is fairly clear from the Khanikoff and others that the Bakhtiari tribesmen can be divided roughly into two classes, the long-headed and the short-headed, the former being for the most part immigrants from the south, representing successive waves of immigration, and the short-headed probably antochtonous. These people plagued the armies of Alexander, but were a source of anxiety long before Alexander. From the earliest times of which we have any record these mountain folk were always ready to fall upon organized government when it became weak, and whilst we may legitimately congratulate the Persian Government to-day on the fact that law and order is now effective on either side of this great range of mountains, we may also be sure that in the event of any weakening of the strong arm of government there, there would, as on the frontier of India, be serious trouble.

I conclude by expressing once more our real gratitude for a fascinating paper. I can confirm all that Professor Gregory has said with regard to the important additions to scientific knowledge which have accrued as a result of the investigations carried out during the past twelve or fourteen years by Dr. Harrison and his colleagues—all geologists, but much more than geologists, for they are scientifically minded men who are prepared to note and turn to account every fact of scientific interest which comes within their cognizance.

The PRESIDENT: Dr. Harrison, you have heard two men who know the country and the subject very well, and they give you unstinted praise and thanks for your lecture. It is my most agreeable duty to thank you on behalf of the audience and the Society, and I do so very sincerely.

I hope that whatever place-names are put in brackets, the native names, whether of lakes or mountains, will be adhered to. However placid the disposition of that charming young lady may have been, I hope that her name will be left in brackets and not as the real name of the lake. I do not know that we have ever seen on the screen here such varied forms of mountains, and certainly we have never heard them more graphically and lucidly described, and we are exceedingly grateful to you.

You would all wish me to thank Sir Arnold Wilson for his remarks. Few people are able to describe in a few moments with such charm the varied histories and interests of a country which is very little known. When I said to Sir Arnold Wilson a few moments ago that very few people have gone to the Bakhtiari country, he replied, "Oh no, it is very well known." Nevertheless, I do not think it is so well known, and I am sure that Dr. Harrison to-night has enlightened us all.

AKPATOK ISLAND (Hudson Strait): The Oxford University Exploration Club's Expedition, 1931: *A paper read at the Evening Meeting of the Society on 8 February 1932, by*

HUGH CLUTTERBUCK

THE idea of visiting Hudson Strait with Akpatok Island as the objective arose from a very natural desire to continue the work started by the Oxford Expeditions to Spitsbergen. This work was later extended to Greenland and Lapland, though the former expedition was mainly ornithological and the latter had a very strong botanical flavour. There is of course an immense amount of work yet to be done in all these countries of the north, but a small summer expedition with limited funds and limited time at its disposal can hope only to visit the more accessible parts, and there it will almost certainly find itself following in others' footsteps. This, it was hoped, would not be the case in the neighbourhood of Hudson Strait, where little scientific work has so far been attempted. A more ambitious scheme to visit Baffin Island was carefully considered but rejected, mainly on the score that there would not be sufficient time to make it worth while. The expedition might also be forced to winter, which it was not prepared to do. An island, of such a size that it could be investigated with reasonable thoroughness in a month, seemed the ideal objective, and for this reason in particular Akpatok Island was chosen. Lying in the mouth of Ungava Bay, just to the south of the New Grain Route through Hudson Strait, it appeared to fulfil most of the conditions we wanted. The objective was thus fixed.

Akpatok has been described as "The Mystery Island of Ungava Bay." Its name has seldom appeared in print. Considering its size on the charts and its accessibility in summer this apparent neglect was rather remarkable. Hudson was reported to have first sighted the island in 1610, but not until 1885 did a white man visit it, when Dr. Robert Bell, of the Canadian Government Geological Survey, landed for a few hours. As a result of this flying visit the east coast was marked on the charts as having cliffs 400–500 feet high along its entire length, and the geological maps labelled the island as Palaeozoic Limestone. There is no further record of any landing except by Eskimo. These Eskimo from the Payne Bay area on the west side of Ungava Bay and from Chimo on the south side were reported to visit the island in the early summer in search of walrus for which Akpatok has a great reputation. With their families and dogs, they crossed to the island in the large boats used by the Eskimo women, the umiaks. These boats have now practically ceased to exist in the Ungava district, and have been replaced by Peterhead motor-boats. Very little other information was to be had about Akpatok. There were no known anchorages, but as the natives visited the south-western end of the island, there was probably a landing-place somewhere on the south-western corner. Akpat being the Eskimo for guillemot, there were presumably rookeries of these birds on the cliffs.

This extremely meagre information made it impossible to decide on any plan of attack until the island was reached and a landing-place discovered. Everything depended on this, and it was anticipated that there might be considerable difficulty in finding a suitable landing and camping site. It appeared

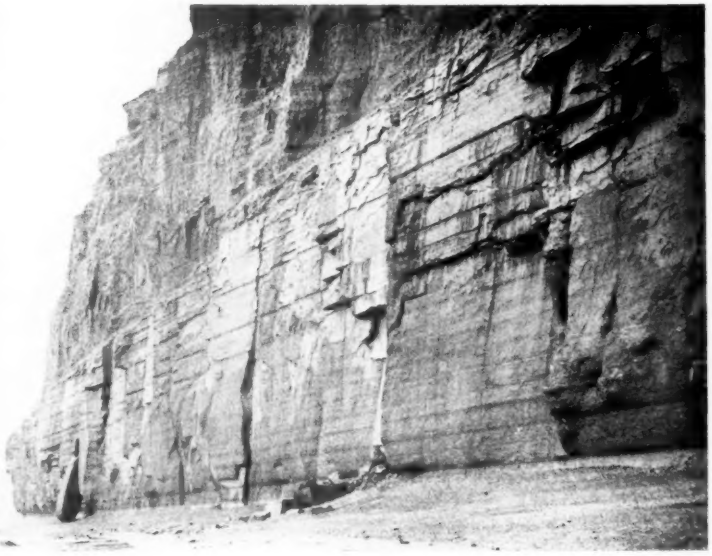
likely that five weeks on the island would be as long a visit as we could reasonably expect. This working period would almost certainly be curtailed to an unknown degree by fog in August and in September by gales and foul weather. There would be no time to tarry on the Labrador coast going north. To get to Akpatok as quickly as possible and remain there as long as possible was our one idea. The cost of the expedition was estimated not to exceed £1500, over £1000 of which was subscribed by members. The Royal Geographical Society granted £150 towards the expenses in addition to lending instruments. A grant of £100 was also received from the Royal Society, while the University Chest and several colleges in Oxford assisted with smaller contributions.

The necessary permits to enter the North-West Territories having been granted by the Canadian Government, the expedition sailed from Liverpool on July 28, bound for St. John's, Newfoundland, which was reached on August 3. The expedition consisted of the following members: Captain C. M. Singer, R.E. (Surveyor), Lieut.-Com. A. J. Langley (Navigator and Meteorologist), H. Hanham (Ornithologist), C. J. D'Aeth (Organizing Secretary), R. J. O. Bray (Photographer), D. Davis (Biologist), A. K. Gregson (Entomologist), I. H. Cox (Geologist), N. V. Polunin (Botanist), and H. M. Clutterbuck.

The Newfoundland Government allowed all our stores to be landed duty free. There is a 50 per cent. import duty on nearly everything entering Newfoundland, so this concession was very valuable, and saved not only money but a great deal of time and trouble. At St. John's we were met by Mr. Geoffrey Milling, who acted as our agent in Newfoundland. Mr. Milling, who was a member of the Second Oxford Expedition to Spitsbergen in 1923, was responsible for all arrangements, and these were admirable in every way. The schooner chartered for the voyage to Hudson Strait had already arrived from Port Union, and thanks to Mr. Milling's efforts she was almost ready to sail. The *Young Harp* was a Newfoundland-built ship of 100 tons, with a semi-Diesel engine of 120 h.p. The engine proved to be her one weak spot. She was a comparatively new ship, built in 1927. We had secured the services of Captain Rideout, an "outport" captain, and the ship was manned by an outport crew. I do not know whether we were particularly fortunate in our choice, but I doubt if any expedition has sailed with a more pleasant or more efficient captain and crew.

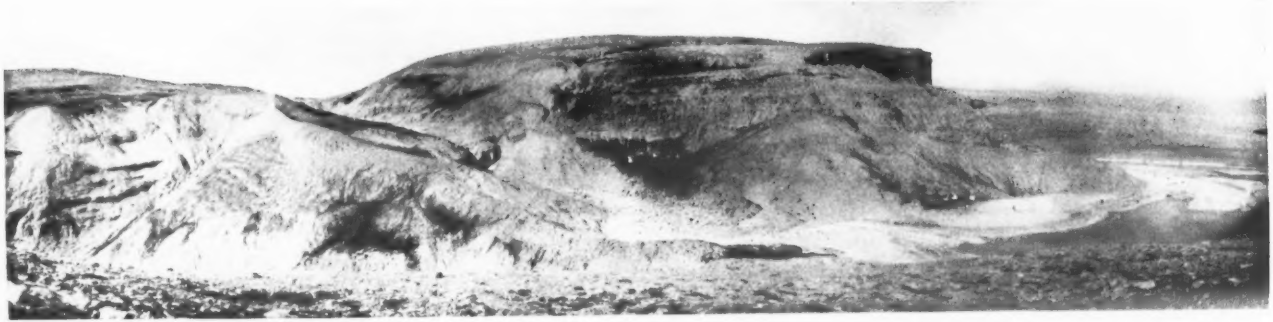
Considerable alterations had had to be made on board to accommodate us. The forepart of the main hold was fitted up with bunks and a skylight took the place of the hatches. An additional galley and storeroom, with temporary partitions, separated the living quarters in the hold from the forecastle. All these alterations were complete on our arrival. The work of transferring our stores and equipment started early on the morning of the 4th, and by the evening everything was on board and we were ready to sail. An induction pipe in the engine however showed signs of leaking, and this defect, the forerunner of a nightmare of engine trouble, took twenty-four hours to remedy. It was not therefore till the afternoon of the 5th that we weighed anchor. Two hours later we were back again, having nearly been shipwrecked at the entrance to the harbour. While in the narrows at the harbour entrance the main bearing of the engine melted and we drifted steadily towards the cliffs. A few blasts on the portable foghorn brought the pilot launch to the rescue, a line was

West coast of Akpatok Island



Cliff face near the base camp

Looking west to Nullataktok Bay: Gulch Cape on extreme right



The base camp, Harp Cove

The base camp, Harp Cove

passed, and the ship was hauled off just as it seemed inevitable that she must strike the rocks. Twenty-four hours' continuous work on the engine followed, and early on the 7th we were ready to start again, and were soon in the open sea.

The following two days we cruised slowly northwards. The engine ran only for short periods, to allow the new bearing to be worn in. The weather was gloriously fine, too fine, as it meant little or no wind for our sails. During the night of the 9th we crossed the Straits of Belle Isle and had our first view of the Labrador coast the following morning. August 11 brought a cold north wind and a choppy sea. We crossed the mouth of Hamilton Inlet and dropped anchor for the night in Indian Harbour. Indian Harbour is one of the summer fishing settlements on the Labrador coast. The fishing schooners come chiefly from Newfoundland and the Gulf of St. Lawrence, and the fishermen and their families have wooden shanties along the shores of these settlements. More than a thousand schooners used to be on the Labrador coast during the summer months, but not more than half that number are now working the cod fisheries. Here too is one of the Grenfell Mission hospitals and a wireless station, which enabled us to send a message to St. John's reporting the engine's behaviour.

Weighing anchor at dawn on the 12th we proceeded north, bound for Burwell. The weather continued fine, and being anxious to make up time we took the Outer Run down the coast. The Inner Run, with innumerable islands between the ship and the open sea, offers comparatively calm water, but takes longer. By taking the Outer Run our course lay in general 10 to 20 miles from the mainland, too far off to see much detail of the coast, though we were not often out of sight of land.

Every day we met a few schooners, laden with cod, sailing south, and one or two icebergs were generally visible, though in August it is usual to have at least a dozen bergs and growlers in sight at the same time. During this period the sky was almost continuously cloudless. On the 15th we sighted Cape Chidley, the most northerly point of Labrador, and approached Gray Strait. Gray Strait has much in common with the Pentland Firth. The currents and tide rips in both are notorious. On the north side of the strait lie the Button Islands, and to the east of the islands lies the Labrador Reef, to which shipping gives a wide berth. The current in Gray Strait is reported to reach a maximum of 7 knots, and there is no reason to suspect that this figure is in any way an exaggeration. The safe and easy course is to stand well out on approaching Cape Chidley and enter Hudson Strait by the main channel, where the current is less and there is more room to manoeuvre in case of difficulties.

This roundabout approach to Port Burwell is often necessary in July and early August, when the strait is choked with ice, but once the ice has gone, Gray Strait can be navigated without much difficulty. We still had a little confidence left in our engine, and calculations as to the state of the tide showed that we had arrived at a favourable time. We therefore entered the strait, and keeping close to the mainland to avoid the current as much as possible were soon through. At 9 o'clock that evening we anchored in Burwell, with the comfortable feeling that we were now almost within sight of Akpatok. In spite of continual engine trouble, and without much wind to help, the voyage from St. John's had occupied less than nine days, and we were well satisfied.

The voyage so far had been remarkable for the small amount of ice sighted and the total absence of fog. We did not take a census of bergs, but there were certainly not more than a hundred on the whole 700-mile coast of Labrador, and they were nearly all small. We were exceptionally lucky to have had such perfect weather and no fog. A schooner that left St. John's four days before we sailed was held up for three days by fog, and only reached Burwell the day before our arrival. Our troublesome engine had therefore been something of a blessing in disguise. The fine weather had also given Langley an opportunity

Coast of Labrador

for making observations on abnormal refraction. During the voyage north the horizon was usually miraged to a greater or less degree, and under these conditions it was not easy to fix the ship's position. The observed altitude of the sun corrected for normal refraction appeared to be too small by an average amount of 5 minutes of arc. Although it was obvious that the horizon was likely to be affected, it was nevertheless well defined, and no other horizon existed. A navigator relying on the normal corrections therefore will probably be anything from 5 to 10 miles out, an error sufficiently large to court disaster on the imperfectly charted coast of Labrador. This miraged horizon would

seem to be the rule rather than the exception during fine weather in August, but no noticeable mirages were observed during the voyage south in September. While we were passing through Gray Strait the Button Islands were very strikingly affected by mirage, and although only some 5 miles away and fronted by high cliffs, they assumed the most grotesque shapes, often completely disappearing from view.

On the voyage north surface sea temperatures were regularly taken, and these showed marked variation. Between the latitudes of 55° and 56° the temperature fell from 45° to 37° F., though farther north it remained constant round about 40°, until the neighbourhood of Chidley was reached and the effect of the colder water issuing from Hudson Strait was felt, the temperature falling to 37° and to 34° at Burwell.

The arrival of any ship at Burwell causes great excitement, and we were no exception to this rule. We were armed with a letter of introduction to the manager of the Hudson's Bay Company's post, and so had hopes of being well received. Needless to say this letter was not necessary, and during our short time at Burwell we were almost overwhelmed with kindness and attention. The Company had arranged for a Peterhead boat and an Eskimo to be available for us, if wanted; but it was finally decided not to risk a valuable motor-boat on the unknown shores of Akpatok. The Hudson's Bay Company showed great interest in our venture from the start, and the expedition was deeply grateful for all their kindness and help. In addition to the Company's post there are two R.C.M. Policemen at Burwell. Five white men in all. The rest of the population consists of about one hundred Eskimos, mostly employed at the Post, and an unknown number of dogs of doubtful temper. In summer the natives live in tents among the rocks overlooking the harbour. The dogs live anywhere and everywhere. Burwell is a difficult harbour to make for those unaccustomed to it. With one exception all the beacons and leading marks have disappeared. The wireless station, erected by the Canadian Government Expedition to Hudson Strait in 1927, has now been moved to Resolution Island on the north side of the strait, but the wireless masts remain. These can usually be seen from seaward before any other signs of the port become visible, and are a great help to those making Burwell for the first time.

The neighbourhood of Burwell is very inaccurately shown on existing charts. Two channels are shown south of Cape Chidley, joining the Atlantic with Ungava Bay, but it seems to be definitely established that the so-called McLellan Strait is the only channel separating Burwell from the mainland of Labrador. The strait is navigable for small vessels. Our captain had passed through it the previous summer, but he did not seem anxious to do so again. This region was, I believe, included in the Aerial Survey conducted by Dr. Forbes's Expedition last summer, so this point has probably been settled.

We stayed at Burwell for twenty-four hours and tried to gather some local information about Akpatok. Estimates as to its distance varied from 100 to 200 miles, so we continued to trust our chart, where the distance shown was about 80 miles. There was not much other information about the island, except that it was inhabited by spirits, who lived in holes in the cliffs. The island was also reported to move. The natives evidently did not like the place at all, and the fact that two families from Payne Bay had wintered there some forty years ago

and had all perished, probably strengthened their dislike for it. On August 16 we left Burwell and set a course to hit off the centre of the east coast of Akpatok. Whatever the currents and the distance might be, we could hardly miss our 50-mile target. Soon after leaving the engine ran another bearing, and with little wind or current to help us we drifted westwards. This breakdown appeared to be the last straw for even our captain's monumental patience. Deciding that the everlasting engine trouble could only be caused by the presence of the devil on board, he disappeared into his cabin and returned with his gun. Somewhat alarmed, we wondered who was to be the Jonah, but our fears were allayed by the appearance of the mate with a piece of wood decorated with a large blue heart. Here was the devil, and it was now for the captain to shoot him, not with shot, but with a silver 10-cent piece. It was a most solemn moment. The range was only 5 yards, but what would happen if the shot missed? Mercifully the heart was well and truly punctured, and every one was satisfied. The same afternoon Akpatok was sighted from aloft, and with the engine going again we made good progress towards our goal.

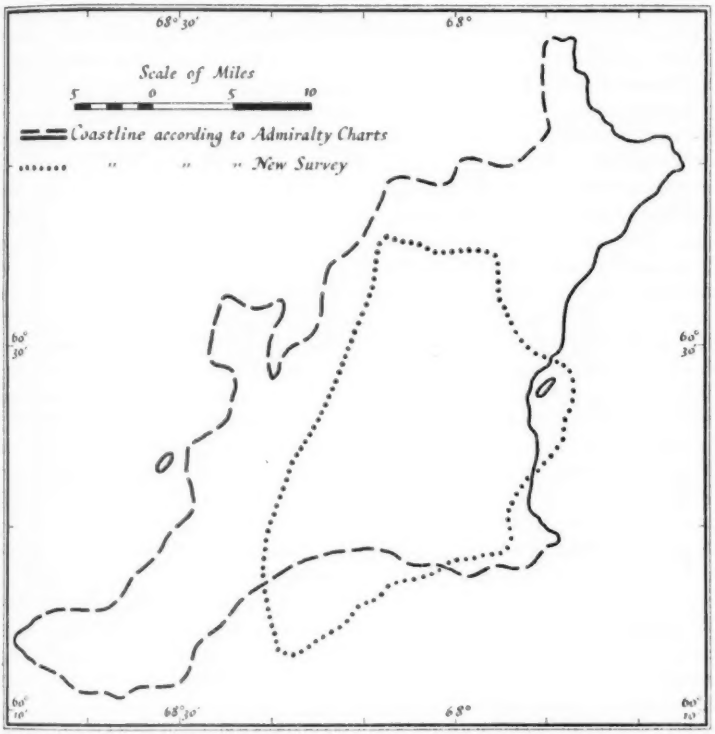
Our first view of Akpatok was rather awe-inspiring. An unbroken line of cliffs confronted us. This had been expected, but, looming suddenly through the mist, these vertical walls, 500 feet high, seemed unusually formidable. Beyond the land rose gently to a skyline some 5 miles inland. The whole presented a picture of remarkable barrenness and desolation. A dirty yellow seemed to be the predominating colour, though through glasses dark patches of vegetation were visible in the more sheltered places. It was not a cheering prospect when seen for the first time on a dull misty evening, and turning southward we proceeded slowly along the line of cliffs. From the base of the cliffs a ledge, 50 to 100 yards in width, projected seawards. Uncovered at low tide, this ledge made any possibility of landing out of the question. Some 7 to 8 miles down the coast an anchorage was found in 7 fathoms a quarter of a mile from the shore. The line of cliffs was here broken and a gap 100 yards wide with a sloping shingle beach in place of the marine ledge made an ideal landing-place for dories in fair weather. All went ashore and prospected for a camp site. Two ravines wound inland. In the larger of the two flowed a stream which emptied into a small lagoon, separated from the sea by a shingle bar. Access to the interior appeared easy, while a few bleached skulls of walrus and bear showed that Eskimo had camped there many years before. It was, on the whole, a satisfactory site for our base camp.

Before definitely choosing this place, which was provisionally named Harp Cove, we decided to look for other possible landings and at the same time to attempt a circumnavigation of the island before sending the ship back to Burwell. Singer and Langley were anxious to conduct a running survey of the coast-line so that we might have a rough idea of the island's size, presuming it to be different from that shown on the chart.

We weighed anchor early next morning, steered south, rounded the south-eastern point of the island, and keeping as nearly as possible 1 mile from land, sailed along the south coast. A break in the cliff-line 5 miles along the coast indicated another possible landing-place. Thereafter the cliffs continued in an unbroken line. Patches of vivid green on the screes at the base of the cliffs showed the positions of the guillemot rookeries, and flocks of guillemots, on

their way to and from their feeding grounds, passed overhead. The south coast should have been 30 miles long. We now realized that the chart was very wrong, for the south-western point of the island was reached after sailing only half that distance. We closely examined this point for the reported anchorage, but could see no possibility of the existence of such a place.

Rounding the point the west coast came into view stretching to the horizon in a perfectly straight line. Though equally inhospitable, the west coast was very different from anything we had so far seen. After a few miles the high



Difference between Akpatok coastline as shown by Admiralty Charts and by New Survey

cliff-line gradually lowered and was replaced by sections of low cliff, each section about a mile in length, and each separated by a steep-sided valley. This alternate cliff and valley formation continued for about 15 miles, but as we approached the northern end of the island the high cliffs again appeared. The west coast was only about 30 miles long. It should have been nearly double that distance. Viewed from the sea the north coast of Akpatok was particularly striking. The cliffs were higher and more forbidding than on any other part of the coast-line. Here was another guillemot rookery, and the sea was covered with immense numbers of these birds. No ravines broke this

sheer and in places seemingly overhanging wall 600 feet high. The thought that we should sail round the island in less than twelve hours had never entered our heads when we started, but there now seemed every probability that this would be done. This probability became a certainty when, on rounding the north-east point, we recognized the coast. For a short distance the cliffs again lowered, even more noticeably than on the west coast, to rise once more to their full height and continue unbroken to Harp Cove. The circumnavigation of the island had occupied less than ten hours.

The same evening we took the ship round to the cove on the south coast that had been noted that morning, and went ashore. Very recent signs of an Eskimo camp were found which could not have been abandoned many weeks before our arrival. Here too was the only rich midden found on the island. It contained large quantities of skulls and bones of walrus, seal, bear, and a few fox. Several broken implements of bone and ivory and parts of harpoons and bird spears were found, but all comparatively modern and of no archaeological interest. A narrow gorge with precipitous sides wound inland, and in this one or two graves were found, but these too were of no great age. From an archaeologist's point of view Akpatok was disappointing. Although this cove was evidently the headquarters of the walrus hunters it was not very suitable for a base camp, and we returned on board.

During our absence ashore Singer had worked out the results of the running survey and had drawn out a rough plan showing the ship's course during the day's run. According to his calculations the distance between our starting and finishing point was shown as less than a mile. Such a small error was flattering as we did not know what allowance to make for current, and at least once the log had been fouled by floating seaweed. The errors must have cancelled out to a great extent, but the result was accurate enough for our purpose. It showed us that the island was not more than half its charted size. Early on the 19th we returned to Harp Cove and started disembarking stores and equipment. The dories were loaded with great rapidity by the crew, who rowed them ashore and discharged their contents on the beach. Everything had then to be carried up the beach to safety above high-tide mark. As luck would have it we had hit off a spring tide and the tide was low. This meant that nearly 5 tons weight of cases and bales had to be man-hauled up 100 yards of loose shingle and with no time to lose, for the tide was lapping at our heels. Wind and sea were rising and the captain was anxious to get away.

By midday the disembarkation was completed and the ship sailed for Burwell, leaving two dories with us. Camp making occupied the rest of the day. We had a large tent for our stores, which was also the mess tent and general living quarters. It was anchored to large piles of heavy stones and weighted down inside by stores boxes ranged round the walls. Four Whymper tents and two tents used in Greenland in 1928 provided the sleeping quarters. In addition we had three Mummery tents, earmarked for subsidiary camps when wanted. In the meantime they were to be used for storing surplus equipment. The sleeping-tents were pitched, some near the mess tent close to the lagoon, others on a small meadow 100 yards inland. The meteorological station was erected on a ridge overlooking the camp. Besides maximum and minimum and wet and dry thermometers the screen contained a thermograph and a

hydrograph. The barograph was kept in the mess tent. These self-recording instruments were lent to the expedition by the Meteorological Office, who also lent the screen. No anemometer was taken, but approximate wind velocities were noted according to the Beaufort Scale.

The wireless receiving set was assembled and found to be in good order. The primary function of this set, an "Eddystone All-wave Four," was to obtain time signals for rating the chronometer, and while on the island the set was normally tuned to receive wave-lengths of from 22 to 45 metres. Time signals from Arlington were obtained without difficulty, but the reception of news was not so satisfactory, though Chelmsford and Paris and some unknown Italian station could usually be heard.

Arrangements had been made for the ship to take us off the island not later than September 20 and, if possible, to call in at least once before that date. This left exactly one month to work the island, which was none too long a time, especially for the survey.

Thanks to the running survey a good idea of the general size of the island had been obtained, and from this we were able to decide on a suitable scale for the survey, and 1 in 120,000 was chosen. From the beginning it was clear that visibility would be limited by the gently undulating nature of the country to 2 or 3 miles from the tops of the ridges. It was decided to use the very light 3-inch vernier theodolite to fix points by triangulation and intersection at 2 to 3 miles intervals all over the island, and to work chiefly from the main camp, with only two subsidiary camps, at each of which Singer would spend two or three nights.

The triangulation sprang from a half-mile base-line measured just north of the main camp. The fixed points were marked on the ground by stone cairns 5 to 6 feet high. In time all became expert cairn builders, and these cairns served a double purpose, as they acted as signposts and were all named. The position of the camp and azimuth of the base were determined astronomically with a Zeiss No. 1 Theodolite, while the heights of the fixed points were determined by vertical angles and referred to the mean sea-level provided by Langley. The heights of intermediate points were found by aneroid. The interior of the island contained little detail to be mapped, as it consisted of a series of ridges and valleys intersected by ravines. With fixed points so close together it was sufficient for the purposes of the expedition to sketch in the detail by eye, helped out by rough compass traverses taken by the surveyor and others when travelling from point to point. This saved the considerable extra labour involved in carrying a plane-table about. The coast-line was dealt with rather more fully, points on it being intersected by theodolite wherever possible and the information obtained during the running survey from the ship was incorporated.

The first ten days on Akpatok were, on the whole, remarkably fine, and we grudged the occasional "office days" that had to be spent in camp dealing with the material collected in the field. This fine weather enabled Singer to push forward his triangulation of the island much more quickly than had been anticipated. It was not always a simple task, as on sunny days cairns were difficult to pick up if over 2 miles away, owing to the shimmer of hot air rising from some intervening ridge that lay just below the line of sight. At other times

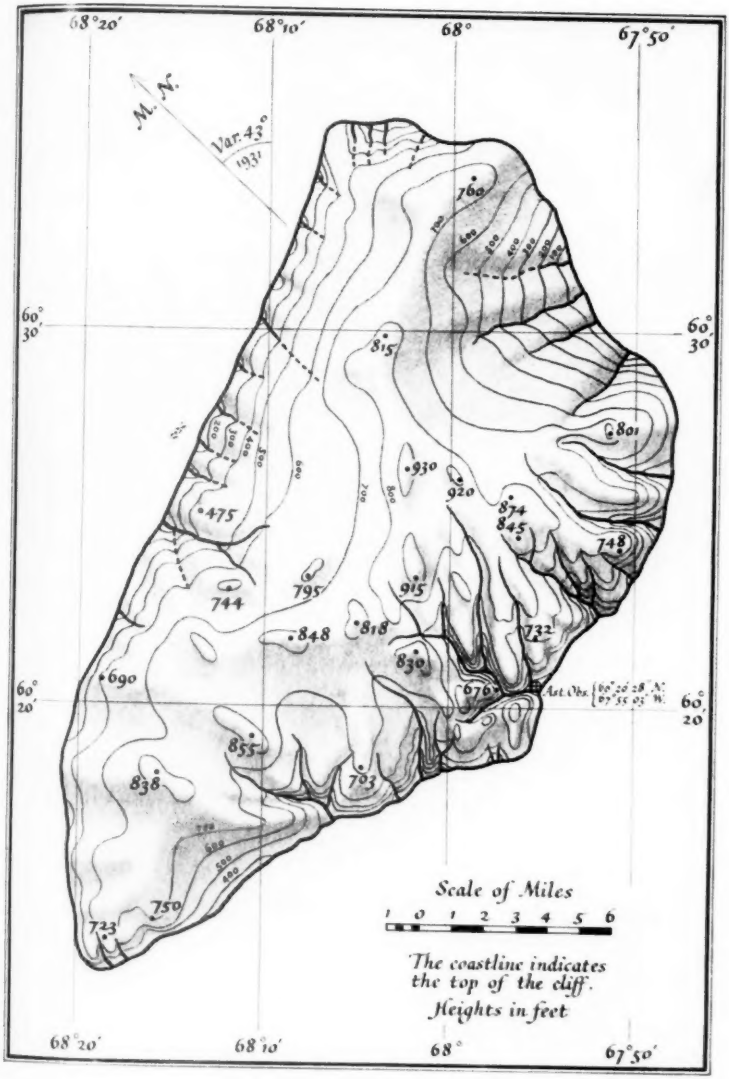
the wind was strong enough to necessitate erecting the theodolite with as short legs as possible for stability, the observer lying full length on the ground. Fog however was absent, or present only for very short periods.

Our daily routine was simple, and in order to take full advantage of the daylight Newfoundland Summer Time was adopted. Reveille was sounded by Hanham with a rifle shot that echoed round the cliffs and usually sufficed to awaken even the deepest sleeper on the Upper Terrace. This was at 7.30, and the only disadvantage experienced in keeping this time (2½ hours earlier than G.M.T.) was that 7.30 usually coincided with the minimum temperature for the twenty-four hours. Breakfast at 8 and supper at 8 were the two fixed meals, rations being drawn after breakfast by those who intended to spend the day in the field. Except when in the immediate neighbourhood of camp, we worked in pairs.

There were three ways to the interior plateau, each involving a short climb of about 700 feet. The easiest way led north past the base-line. The way to the south meant a scramble up 700 feet of loose scree and was not so popular. To the west broad terraces separated by scree slopes had to be ascended, but in each case the interior plateau was easily reached.

The stream at the mouth of which our camp was pitched proved to be easily the largest on the island. It had many tributaries, nearly all dry at this time of year. Each tributary however meant a valley of varying width and depth, similar in appearance to a railway cutting but sided with unconsolidated scree. The bottoms of these valleys were frequently choked with quantities of boulders of all sizes, and their general appearance gave evidence of the volume and velocity of the water in them when the annual thaw takes place in the early summer. Very little snow remained in August except in the more sheltered ravines. The stream which emerged at our other landing-place was the next largest, and these two with their numerous tributaries drained nearly a third of the whole island. This was the most interesting part of the island, but owing to the network of ravines, it was also the most difficult to cross. Nearly every ravine meant a detour of sometimes as much as half a mile, which made it hard to march on a compass bearing with any accuracy. We found that all our compasses behaved satisfactorily, though they took an abnormally long time to settle. While marching in fog, when bearings had to be taken every 100 yards, progress was very slow.

The central plateau was featureless and monotonous, but the going was generally good. The ravines were replaced by broad shallow valleys and no detours were necessary. Small shallow lakes dotted the landscape and there were considerable stretches of tundra land. Many of the lakes were dry and the hummocky ground, though tiring to travel over, was not soft enough to impede progress. Compared with other parts of the island these stretches of tundra were rich in vegetation, and in June and July are no doubt swarming with mosquitos and black fly. In August these pests were not much in evidence, and it was never necessary to use head-nets or any of the other anti-mosquito preparations we had brought with us. Taken as a whole the south-west part of the island was the flattest and least interesting. Tundra land predominated and there were no hills of any distinction. The northern half of the island afforded the best walking. The ravines there were never more than deep



Akpatok Island

Looking south from a point 5 miles north of the base camp

Dry river bed inland

valleys, though the very extensive stone polygon areas played havoc with the stoutest boots. Fortunately Cox was an efficient cobbler, and much of his spare time was spent at his last. These polygon areas were a feature of the northern half of the island and were more extensive and striking than similar areas observed in Spitsbergen.

During the last half of August the day air temperature averaged 48° F. (6 a.m. to 6 p.m.), the average night temperature being only 1° lower. The day humidity at 70 per cent. and the night humidity at 80 per cent. would seem to correspond roughly with the average winter humidities in London. No rain fell during this period, and there was no fog of any account. Only once did the wind reach gale force.

By the beginning of September all work had progressed so far afield that it was decided to establish the first of the subsidiary camps towards the south-west of the island. On September 2 Langley and Bray crossed the island to the west coast prepared to spend the night there, as it was too far to go there and back in one day. We had spied a possible landing-place from the ship, and this they intended to investigate. It rained heavily during the night, and on the 3rd we had our first day of real fog. Gregson and Polunin were to be the first pair for the subsidiary camp. Hanham, D'Aeth, and I carried the camp and Singer led the way with the compass. Progress was slow and the prospect of hitting off the camping site became remote. We accordingly altered our direction and struck for the south coast, pitching the camp in a sheltered spot close to the cliff edge.

We returned to the base to find Langley and Bray already home with their report of the west coast. They had found enough driftwood to keep a good fire going all night. In this they were lucky, for we found no driftwood on any other part of the coast. Driftwood is reported to be very scarce in the neighbourhood of Hudson Strait.

On September 5 Gregson and Polunin were relieved and the camp was moved to the spot originally selected. Cox and Bray took over for two nights to be relieved in their turn by Singer and D'Aeth for three nights. By this arrangement the survey of the south was completed and each scientist had the opportunity of examining the district.

The weather on the whole continued to be favourable until the 10th, when Singer and D'Aeth returned to the base in fog and rain. This long spell of fine weather had enabled more work to be done in all departments than we had dared hope for. On most days the sea was calm enough for a dory to be launched, and Davis was able to indulge in the cold and unpleasant task of plankton collecting. Lines of soundings were run out, but no soundings exceeded 12 fathoms, which agreed with the accepted report of the shallowness of Ungava Bay. Tidal observations were undertaken by Langley. Commencing early on the day of full moon observations were continued for thirty-two hours. The height of the tide was noted at half-hourly intervals except at times of expected high and low water, when the heights were recorded every fifteen minutes for an hour before and an hour after the anticipated time. During the hour before and after high tide, readings were taken directly off the 10-foot tide pole fixed in the beach, but at other times the position of the water-line was taken relative to a specified stake, eight of which were fixed at regular

intervals down the beach. This tide watching was a tedious business, but we were anxious to get accurate results. The highest tides observed between August 19 and September 19 occurred on September 13, and gave a range of 31 feet, the lowest observed range occurring on the 5th, and measuring 12 feet. Very high tides are reported at Chimo and Payne Bay. They may well cover a range of as much as 35 feet. At the head of Frobisher Bay in Southern Baffin Land 40-foot tides are rumoured.

The *Young Harp* called on September 8 on her way to Payne Bay and the captain came ashore for an hour and inspected the camp. I arranged to be ready for the ship to take us off any day from the 17th onwards, depending on the weather: in any case not later than the 20th. We brought ashore a reserve supply of paraffin and embarked some cases of geological and other specimens.

The weather was now deteriorating, as was only to be expected. The humidity in particular was very high. The temperatures were never low, but the night humidity averaged 90 per cent., which made it feel unpleasantly cold. On September 14 the second subsidiary camp was established halfway between the base and the north coast. The camp was made close to a ridge of singular appearance. It was one of the most conspicuous objects on the island, and was visible for several miles. D'Aeth and Polunin were to spend one night here, followed by Singer and Cox for two nights. The camp would then be fetched in on the 17th. After helping to make camp Singer and I returned to the base. The weather had been threatening all day, and during the evening the wind became more violent, accompanied by rain. The temperature fell, and during the night there were snow flurries with a strong north-west wind. In the early morning the temperature touched freezing-point for the first time. At 7.30 that morning Polunin appeared in the mess tent dazed and exhausted, his boots in ribbons. D'Aeth was in a ravine about a mile away too tired to move. This was the only coherent statement that could be gathered. There was no time to learn what had happened and why they were not in their camp. A search party left immediately, and in little more than an hour D'Aeth was found in a ravine about 1½ miles north of the base. He was alive but delirious. All efforts to restore circulation failed, and on the way back he became unconscious, and died before camp was reached. During all this time the snow and wind continued unabated.

The previous evening they had failed to locate their tent when returning from the northern part of the island and decided to make for the base camp 6 miles away. It was undoubtedly an error of judgment on their part not to have turned back sooner in face of the threatening weather. The comparatively short distance to be covered and the fact that, until the weather closed down, the ridge above the camp was visible to them, both probably contributed to cause them no anxiety as to their return journey. It was dark when they started for the base, and in the darkness D'Aeth, who was leading with the compass, fell down a ravine. Apparently he was not seriously hurt, but the compass was lost. During the night they wandered far off their course, till they came to the ravine where D'Aeth was found, and decided to follow it down to the sea and return along the shore. This they started to do, but D'Aeth was now too tired to walk, and they halted and waited for daylight. As soon as it was light Polunin crawled out of the ravine, recognized a survey cairn on the horizon,

and realized they were little more than a mile from home. By this time D'Aeth was unable to move, so leaving the rest of his food with him, Polunin struggled on for help. Such were the bare facts of the tragedy of September 15. D'Aeth was very literally the life and soul of the expedition. He was the originator of the whole idea, and as Organizing Secretary he had worked whole-heartedly to ensure its success. He had no knowledge of the word defeat, and set no limit to his own powers of endurance. Had he been less determined he might well have given in during that night, and by conserving his strength till daylight all might have been different. Such an idea was altogether contrary to his nature, and would never have entered his head.

On September 16 the northern camp was brought in. The day was fine and Singer was able to complete the survey of the island. In camp a start was made packing up in readiness for the arrival of the *Young Harp*. The 17th and 18th were occupied in dismantling camp and preparing for the evacuation of the island. Polunin was sufficiently recovered to cause no anxiety, though his feet were badly bruised and he could only walk with difficulty. Leaving the island was obviously going to be more difficult than landing on it. If the sea was at all rough it was not going to be easy to load dories on an open beach without fear of capsizing them. Much could not be packed till the actual arrival of the ship, but all that could be spared was stacked on the beach above high-tide mark. Everything was marked in order of importance, scientific specimens and instruments to be embarked first, heavy reserve stores last, and, if necessary, to be abandoned. Early on the 19th the ship appeared and anchored off the cove. The day was not an ideal one, with a strong north wind and a choppy sea. The captain came ashore and the work of embarking was started without delay.

The wind and sea increased steadily and there were some anxious moments. The crew as a whole, and the captain in particular, were magnificent, and by 5 o'clock all were on board. We were forced to leave a few of the heavier stores behind, but everything that mattered was brought off. By this time a full gale was blowing from the north, and the cliffs afforded the ship little shelter. We dropped our second anchor and prepared to ride it out. The gale blew all night with alternate rain and snow, but by morning the wind had slightly dropped, and weighing anchor we sailed for Burwell. A high sea was running, but the *Young Harp* made light of it and we hardly shipped any water.

Land was sighted at 5 o'clock that evening, but we failed to recognize it. The storm of the previous night had covered the hills with their first coating of snow and no familiar landmarks were visible. We were too far to the south. It seemed probable that we should have to spend the night in the unpleasantly rough waters of Ungava Bay, but as dusk fell we picked up the entrance to Burwell and were soon at anchor.

On the 22nd we left Burwell in the evening, and with the tide in our favour were through Gray Strait and round Cape Chidley by midnight. The prevailing wind on the Labrador coast in late September should be north-west, but for the next week we experienced winds from every direction except north-west. The evening of the 23rd found us sheltering in Schooner Harbour, at the entrance to the long fjord at the head of which stands the abandoned mission station of Ramah. Here we stayed for two days, while a south-east gale blew

itself out. We proceeded south on the 25th, but the wind soon freshened from the east and we put into Hebron for the night, leaving at dawn on the 26th. By midday there was a gale blowing, this time from the north. We were blown round Cape Mugford, and the weather showing no signs of improvement we were forced to run for shelter into Cut Throat Tickle, a tiny anchorage well inside the fringe of islands that from Cape Mugford extend southwards for several hundred miles. We now took the Inner Run, calling in at Ford's Harbour, where we went ashore for a few hours. The charter of our schooner expired on October 5, and we were getting behind time. The long-awaited north-west wind now appeared, and we made rapid progress. A call was made at Gready Harbour to wireless St. John's the probable day of our arrival, and also to get coal from the whaling station. Next day, with the wind still in our favour, we made a record run, and crossing the straits of Belle Isle were once more in Newfoundland waters. Midnight of October 3 found us in the narrows at the entrance to St. John's Harbour, and here the engine, which had behaved splendidly all the way home, stopped in exactly the same place as two months before. We anchored, hoping every one in St. John's was asleep, and our absurd situation would not be noticed. The trouble was quickly righted and we were soon in harbour. The voyage from Port Burwell had taken eleven days. We paid off the following day, and on October 9 sailed for Liverpool.

As a result of the expedition's survey Akpatok is found to be no more than half its supposed size, while the shape of the island bears little resemblance to that shown on existing charts. No islands exist in its immediate neighbourhood and there are no harbours or safe anchorages. It may be permissible therefore to doubt the accuracy of the charts with regard to the positions and size of other islands in the vicinity of Hudson Strait, particularly the Mill Islands, Salisbury Island, and Nottingham Island. These islands lie directly on the New Grain Route from Port Churchill, and would therefore appear to merit close attention.

APPENDIX I.—THE PHYSICAL GEOLOGY OF AKPATOK ISLAND

I. H. Cox

Akpatok Island is formed entirely of a horizontally bedded Ordovician limestone series. But although these limestones are in part extremely fossiliferous it is intended here solely to describe very briefly the geomorphology of the island.

The Coast-line.—The most striking feature of Akpatok Island is its coast-line, the whole perimeter being cliffed from a height varying from 100 to over 600 feet and falling with superb perpendicularity to the sea. The brow of these cliffs is, for the most part, exceedingly angular, showing that the intensity of sub-aerial erosion is surpassed by that of the sea. At the foot of the cliff is a rock shelf extending some 70 yards seaward and completely submerged at high tide. This is rarely the resting-place of detritus, since the powerful sea currents keep it permanently scoured.

Here and there the stretch of cliff is broken by narrow gorges, the larger of which have been cut down to sea-level, while streams cascade down the cliff face from the lips of the smaller. It is toward the south-east of the island that streams are more frequent, consequently here larger gorges occur.

The coast-line is singularly unindented, but especially remarkable is the west coast, which extends from the North-East Point for 21 miles in a straight line.

The cliffs, here constantly 250 feet in height, have a form differing from those elsewhere, for they are divided up by river valleys into short stretches never more than a mile in length. It may not be discussed here whether this striking outline is the result of intense marine retrogradation alone or whether agencies (*e.g.* faulting or uplift) have to be invoked in addition to account for it.

Drainage.—The prospect of Akpatok Island from the sea shows immediately that the topography of the island is the result of erosional work of two distinct ages. The intensely retrograded cliff and the steep-sided gorges are patently young features, while inland a gently undulating plateau stands as evidence of almost complete peneplanation at a more remote date. Furthermore, in the cliffs sections gradually sloped mature valleys can be seen to lie vertically above the gorges.

Inland the distinction between these two ages can still be seen. In the neighbourhood of the watershed the land surface is a plateau and the watercourses (which were dry in August) start very gradually and with gentle bounding slopes. But as these valleys are traced toward the sea they are seen suddenly to steepen their grade and to cut a channel within the ancient valley. These channels rapidly increase in depth and assume the proportion of gorges sometimes over a mile before they reach the sea, thus rendering travel between adjacent positions near the coast exceedingly arduous.

It will be seen that this gorge cutting is the result of renewed activity of the stream, and the writer hopes shortly to be able to point out the probable cause of this rejuvenation.

Surface features.—The weathering of those limestones that form the island is typical of that found in any normal limestone area where both frost and water are agents and the former dominant. Hence when the limestone is exposed on a horizontal plane water accentuates the joints by solution, with the result that in sheltered places pillars of rock may be left standing. Contemporary with this erosion by solution, frost causes disintegration by flaking off plates along the bedding plane, thus producing one of the most characteristic features of the island—an immense amount of fragmentary limestone that litters the surface everywhere. On the plateau these fragments do not lie to any great depth, but on the slopes down to the watercourses they rest as exceedingly formidable screes and often, if the slope be at all steep, of great thickness towards the base of the incline. The occurrence of these screes is particularly characteristic of the island, and it is not at all uncommon to find a slope which reaches a height of 200 feet entirely masked in this fashion. The material, unbound by any vegetation, seems rarely to be in a state of equilibrium for long.

On some parts of the plateau, usually between 400 feet and 700 feet, there is a distinctive sorting of frost-formed limestone fragments on the surface by the grading of these chips into polygonal-shaped areas so that the larger lie on a raised circumference and the size of fragment decreases constantly to the centre. The margins of such polygons may be further accentuated by vegetation which shows a reluctance to colonize the interior. In diameter they are rarely more than 4 feet and usually less; however considerable areas are entirely covered with such a pattern, especially on the eastern centre of the island and the wide terraces through which these heights fall to the cliff.

The effect of glacial material on the topography.—Further surface material is provided by remnants of glacial material. Evidence for glaciation is very apparent, but the rapid washing that must accompany thawing has left little behind of such deposits. What remain are exotic boulders mainly metamorphic, quartz sands, and a small amount of mud; the occurrence of all in the original position where they were laid down being very limited.

The sands with boulders are restricted to the higher parts of the island inland; of these the principal remnant forms a ridge whose apex reaches a height of 920 feet, almost the greatest altitude of the island. The length of this ridge is about 250 yards, and its height above the plateau does not exceed 60 feet. It presents a rugged appearance due to the sheltering of part of the sand by boulders while the remainder has suffered from washing. A very much smaller mound lies nearly 5 miles inland from the eastern coast. Westward from here is a series of smaller and conically shaped deposits, rising to no more than 15 feet and with small lakes and hollows associated. These cones have far less boulder material in them and even a little comminuted limestone.

With respect to these deposits there is an interesting correlation of geology, zoology, and botany: the ptarmigan which inhabit the island require specifically grains of quartz for their crops and thus resort to such places to obtain that which is otherwise not present; as the birds sit on these mounds their droppings fall about them and eventually render the very sandy material botanically habitable. Thus it is found that vegetation in such places is much less rare than on the surrounding limy ground, especially at the apices, where the birds show a preference for sitting.

The present distribution of erratic boulders is far from uniform. They are more commonly met with in the southern half of the island and decrease almost to absence northward. Their form moreover varies from east to west. In the east, where the streams are active and have worked with no mean effect far inland, the erratics are found chiefly as smallish and rounded boulders in the stream beds, where they are extraordinarily abundant. In the same part of the island, but on the plateau, inland of the rejuvenated features, the boulders occur tightly packed together in sunken areas usually of small diameter; but even here they are rounded and of no great size.

The country bordering the southern 8 miles of the western coast is very distinctive. Watercourses are non-existent more than half a mile inland, and the ground, thus unbroken, rises in terraces very vaguely defined from the coast to the ridge at 750 feet which occludes this district from the east. These terraces represent merely the serial outcrop of successive bedding planes with the gentle fall in ground-level, and would seem to have no significance beyond this. It is the most monotonous country. Vegetation is more prolific than elsewhere on the island, a fairly thick hillock-tundra flora occurring on the terraces below 700 feet. This district is also richer in small lakes than any other; they are most frequent on the stretches bordering the cliffs.

The habit of erratic boulders here is similarly distinctive, for they are large in size and usually tabular, showing evidence of no other transportation than of the ice that brought them. These blocks, often as much as 5 yards long, when seen from the high ground overlooking the south-west country have the semblance of cattle lying on the ground, such is their shape and grouping. In number they increase seaward to the south and west, being almost absent above the 700-foot contour.

The reason for these erratics differing so from those of the east is not far to seek: drainage in the south-west is not ultimately surface drainage, as the lack of watercourses shows; but there are numerous swallow holes that carry off water. These, which occur between the 550-foot and 650-foot contours for the most part, are frequent within a small area and are not choked with boulders. Thus the country, not being corrugated by rivers and further dissected by their rejuvenation, offers no force such as gravity and fluviatile action to disturb the boulders, and the surface consequently being stable is in a position to support vegetation.

Soil.—Soil on the island is exceedingly scant and is only developed in any

quantity on the slopes representing the ancient valley and bordering the present stream gorges. These "meadows" occur at heights varying from 200 feet to 600 feet near the sea, and on account of their modicum of soil can hold water to a sufficient extent to support vegetation. It is always on such slopes as these that the Eskimo camp when they visit the island in spring, since they offer more warmth and softness than elsewhere. One hole dug in such a meadow at about 500 feet showed that the soil and subsoil of limestone fragments lay to a depth of 2½ feet and rested on solid limestone that had the appearance of ice planing. By far the greater part of this thickness contained much limestone and the soil itself was light and with a certain amount of clay.

The above description deals but briefly with certain aspects of the physical geology alone. Much remains to be said with regard to the origin of Akpatok Island and especially the fossil fauna at present being worked upon, which already yields promising results. Such conclusions as are reached from their study will, it is hoped, be published in those journals devoted particularly to that branch of science.

APPENDIX II.—THE ANIMAL COMMUNITIES OF AKPATOK ISLAND

D. H. S. Davis

The fauna of the island can be considered under three main headings: (1) sea, shore, and cliff communities; (2) freshwater communities; (3) land communities.

1.—At the northern and south-western corners of the island colonies of guillemots inhabit the perpendicular cliffs, where they are particularly high, rising to well over 600 feet. Brunnich's, Mandt's, or Black and possibly Common Guillemots colonize the ledges and crevices of the cliff face. These birds were present in tremendous numbers and were to be seen feeding in great flocks at sea; the Brunnich's farther out, the Mandt's nearer shore and in smaller flocks. Early in September they suddenly migrated southwards. The only other sea birds were the Eider Duck and the Glaucous Gull. There were no Herring Gulls or Kittiwakes, though the latter were seen in Ungava Bay on our way to Akpatok. The Glaucous Gull was seen to be chased by the Peregrine; the Peregrines lived on the cliff edge, nesting in crevices; there was one pair to about 5 miles of coast-line, and they were to be found all round the island.

The only mammals seen were seals, probably the Big or Great Bearded Seal (*Erignathus barbatus*). The skulls and bones of walrus slaughtered by the Eskimo bore testimony to their presence near the island in the early summer.

On the rocky ledges that run down to the sea from the shingle at the base of the cliffs are great numbers of molluscs (*Littorina rudis*) living in crevices of rock and browsing on the seaweed; innumerable shrimps (*Gammarus locusta*) live in the small pools on these ledges, congregating under stones and boulders. The red shore mite (*Bdella littoralis*) was very abundant on the shore from the edge of the water to the base of the cliff, and sometimes in the ravines at a considerable distance from the shore. Under similar conditions in Ice Fjord, Spitsbergen, the same community of animals is found.

In the drift-line, consisting of decaying seaweed and other detritus, there were great numbers of small worms, fly larvae, and springtails; flying over the decaying mass were countless scavenging flies.

A tow-net for collecting the larger planktonic animals was taken. Horizontal and vertical hauls were taken about a mile off shore from the south-eastern coast of the island. The material has been deposited at the British Museum where it is being worked out by specialists. The most numerous organisms in the plankton

were copepods; jelly-fish were abundant in numbers but relatively few in species; other animals were pteropods (one species); arrow worms, marine worms, etc. The pint jar at the end of the net was always solid with life after a twenty-minute horizontal haul, this great density being typical of arctic waters.

2.—The freshwater system consisted of shallow tarns of small size, not often exceeding 3 feet in depth; they would therefore be frozen to the bottom in winter. As a result there are no fish in them and therefore no divers. The only bird was the Long-tailed Duck, which fed on the lower organisms; water-fleas, fly larvae, etc. There were no geese. Two species of water-beetles were commonly found in the detritus at the bottom, and here also was one species of water-mite. White-rumped Sandpipers were seen picking out the fly larvae in the soft mud at the edge of the tarns. The streams that drained the watershed and melting snow and ran down the ravines and gorges to the sea were practically barren of life; the only animals being the larvae of the Simuliid Blackfly or Buffalo Gnat which adhered to the filamentous algae on the stones and boulders of the stream bed. Occasionally small pools would be left by the drying up of the streams, in which a fauna similar to that found in the tarns was noticed. There were no freshwater mollusca; neither were May-flies or Caddis-flies found breeding in the tarns or streams, and no adults were seen.

3.—From the winter sea-ice comes the polar bear and the arctic fox. The bears were exceptionally numerous for so small an area. They subsist in the summer on a vegetarian diet. Traces of foxes were found, but none were actually seen. There were no lemmings, so the foxes have to depend on ptarmigan and other smaller birds for food during the summer months. There were no hares, ermine, wolves, or caribou.

A collection of animals was made in the different habitats to build up an ecological survey of their communities. The land animals may now be roughly divided up into plateau and valley communities. The birds that were more confined to the plateau and valley heads were the Snow Bunting, the Lapland Bunting, the Horned or Shore Lark, the Rock Ptarmigan, and the Golden Plover; Snowy Owls were seen occasionally; ravens also, though they were scarce and would have to cover great distances in search of refuse and carrion, which was not plentiful. There were no Redpolls or Wheatears. The typical bird in the ravines, especially nearer the shore, was the American Pipit. These obtained their food from the valley slopes and drift-line. The White-rumped Sandpiper flew in flocks along the shingle, settling on the drift-line to feed on the springtails, etc. The Purple Sandpiper was also seen on the shore-line, but whether it was actually resident is uncertain, as it was never seen inland. The migratory birds were the American Turnstone, Purple Sandpiper, Hudsonian Curlow, and Semi-palmated Plover.

The most abundant insects were flies. Scavenging flies were very common on the drift-line and in the ravines; Chironomid flies round pools and tarns and near streams; Black flies in the ravines and penetrating to the plateau nearby. There were also a few Hoverflies, one Sawfly, and a number of Parasitic Hymenoptera whose hosts were the butterflies, moths, and other flies. There were two butterflies, a Clouded Yellow and a Fritillary, both quite common until the end of August, when they completely disappeared. These both frequented the more sheltered of the valley slopes and marshy valley heads. Three species of moths were often to be seen flying in the less open parts of the valleys. A striking thing was the comparative scarcity of mosquitos; this may be accounted for by the lateness of the season, as they breed in the early summer, and also perhaps by the absence of blood; at Port Burwell in the middle of August there were still a number about. Altogether about three species of plant lice or aphids were

found, although not abundant. A few small carnivorous ground beetles were found under stones and a large weevil in places where the vegetation was rather more luxuriant. Under stones on the valley slopes a slug and a snail were present, the latter in small colonies. Springtails and mites were very plentiful under stones and in the roots of plants. Where a little humus had collected round the roots of plants were to be found many small earthworms. The spiders numbered about nineteen species, and were particularly interesting in that at least half of them have been found by Dr. Jackson to be common to Akpatok and the tops of some mountains in Scotland. Many were hunting spiders.

Clearly the fauna of Akpatok presents peculiarities due to the geological structure of the island which determines the nature of the habitats suitable for colonization; comparisons with the collections made by the O. U. Greenland Expedition in 1928 in Godthaab Fjord show that the Akpatok fauna is certainly less rich. At the same time it is quite definitely richer than the most fertile parts of Spitsbergen. Akpatok is some 300 miles south of Godthaab and is subject to the influence of drift-ice. It is interesting to note that the outer coast of Greenland approaches the fauna found on Akpatok. It is also interesting to compare it with Bear Island, lat. 74° 30′ N. Bear Island is subject to heavy fogs and frosts owing to the meeting of the Gulf Stream and the arctic ice. Akpatok is much nearer a continent and is therefore subject to a continental climate. On Bear Island, except for the absence of snails, slugs, butterflies, moths, and aphids, the groups of lower animals are much the same, though definitely poorer in number and species. The freshwater communities are similar except that there are fish and diving birds on Bear Island (Summerhayes and Elton, *Journ. Ecology*, vol. xvi, August 1928; and vol. xi, September 1923).

The general character of the fauna of Akpatok seems to be continental, although the richness and diversity of animal inter-relationships to be expected from a continental fauna is greatly modified by the severe climatic conditions, and the form and nature of the limestone of which the island is made.

APPENDIX III.—SOME NOTES ON THE VEGETATION OF AKPATOK ISLAND

N. V. Polunin

The most striking feature of the vegetation of Akpatok was its extreme and almost uniform poorness over most areas. The shores and perpendicular cliffs of limestone which extended most of the way round the island were of course quite bare, while the plateau behind, which constituted almost the whole area, supported at best only a sparse open community of dwarf herbs and ground-shrubs, generally reduced to close tussocks.

The reasons for this remarkable poorness and extreme Arctic type in spite of the lowness of the latitude were, first and foremost, the exposed nature of this predominating plateau, generally quite unprotected from the gales of the district, which swept them bare of any protective snow covering in winter, and, added to the basic effect of a hard and truly Arctic climate with its attendant short growing season, made conditions extremely difficult for plant growth. In addition to these frequent gales the island is often fog bound, and added to all these disadvantageous effects we have the considerable one of the everlasting limestone of the island.

Altogether it was not at all surprising to find the vegetation of the plateau, and indeed of the whole island, comparing unfavourably with that of the adjacent mainland, where most of the habitats were more sheltered and the rocks allowed accumulation of humus.

Except on the still more exposed hilltops, where the limestone was of large, frost-sheltered splinters supporting only a few almost invisible specks of crustaceous lichens, the plateau was covered with stone polygons. Their soil centres were usually quite bare, but the stony in-between tracts, besides supporting numerous small mosses and lichens, including conspicuous white patches of *Cetraria nivalis*, were generally covered by close, dark-coloured tussocks of *Dryas integrifolia* and flat-pressed bushes of *Salix arctica*. Though they sometimes spread 2 or 3 feet laterally, these *Salix* bushes were never more than a few inches high even in the most sheltered places, and the thickest axes of about 1·5 centimetres in diameter had taken some thirty years to reach that limit. There were not even any dwarf birches on the island, the tallest plants being the occasional axes of *Carex misandra* and some grasses which reached a foot in height. They were not so high on the plateau, where occasional saxifrages, especially *S. oppositifolia* and *S. aizoides*, occurred.

On the other hand, in damper, more sheltered depressions, in the occasional valleys, and around small lakes and bogs, conditions were much better, with the vegetation sometimes quite closed. Here there was a good snow covering in winter, and we found *Salices* and *Carices*, grasses and mosses, often forming little peaty hillocks in the damper areas. The wettest situations and the edges of the numerous little lakes supported fine beds of cotton grasses (*Eriophorum*) and a large grass *Arctagrostis latifolia*, while drier, better-drained areas which nevertheless had a kindly covering of snow in winter were covered by a close *heath-mat* of ground-shrubs about 4 inches high, chiefly the Arctic bell-heather (*Cassiope tetragona*), but also including *Vaccinium uliginosum* var. *microphyllum* and *Empetrum*, both of which produced edible ripe berries, and generally some *Rhododendron lapponicum*.

Where the snow drifted and remained late into the growing season there was developed a dwarf community of almost pure *Salix herbacea*, while areas left still later by the melting snow and usually remaining fairly wet supported but a mixed open community of *Oxyria digyna* and *Saxifraga* species.

Of peculiar habitats we need only mention two, the occasional glacial accumulations of gneissic boulders and soil which allowed of the development of a better but very mixed vegetation even in exposed plateau areas, and the thick lush patchwork mat of mixed and many-coloured mosses and lichens which was developed above the bird cliffs at both ends of the island.

It was largely these exceptional habitats which brought up the flowering plants to over a hundred species and varieties, including not a few familiar European, Arctic, and Alpine types. Elsewhere the vegetation was almost uniformly poor and consisted mainly of the few dominant species already mentioned, to which, perhaps, should be added the *Draba* and *Cerastium* species which were common on all but the most dynamic of the great screes. Ferns and other *Pteridophytes* were few, but the mosses included over fifty species and varieties, while the lichens were still more numerous.

Even the seaweeds on the shelving shores of limestone rock were reduced by storms and the grinding action of ice to close-growing bobbles a few inches long, though enormously long *Laminarians* existed well below low-tide mark.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: The coast of Labrador, especially the northern coast, is very little known, and the islands off that coast even less known. It gave us therefore particular satisfaction when we heard that Mr. Clutterbuck was going to lead a party of the

Oxford Exploration Club during part of the Long Vacation to investigate the island of Akpatok, which lies in Ungava Bay. Those who are not very familiar with such places will soon have an opportunity of seeing where they are. We were particularly glad also to be able, in some small way, to assist Mr. Clutterbuck's expedition financially. Mr. Clutterbuck was at Eton and at Oxford. Subsequently to that he went with Mr. George Binney's expeditions to Spitsbergen in 1923 and 1924, and he was for some months with Mr. Kingdon Ward on the Assam–Burma frontier. With that behind him we knew that we could place implicit reliance and confidence in Mr. Clutterbuck as a leader, and also that, though perhaps not exactly a scientist himself, he would take with him those who would bring back scientific results. That confidence has been justified, and in every particular. We welcome Mr. Clutterbuck very much indeed this evening, and I would now ask him to deliver his lecture on the island of Akpatok.

Mr. Clutterbuck then read the paper printed above, and a discussion followed.

The PRESIDENT: We are very glad to have with us to-night the Governor of the Hudson's Bay Company, and I shall be pleased if he will address us.

The GOVERNOR OF THE HUDSON'S BAY COMPANY (Mr. P. ASHLEY COOPER): I have the greatest pleasure in coming here to-night because those of you who read the financial papers probably appreciate the fact that the Governor of the Hudson's Bay Company does not have many pleasant hours these days. To-night it has been not only a pleasure but a matter of great interest to me to be here, because I have heard a number of interesting things. I have listened to a lecture about the great area over which I have a certain amount of control. It is just two hundred and sixty-four years ago that a small vessel started from England. Some merchants of the City of London decided, when they heard the news that there was great wealth to be found in Hudson's Bay, that they would send an expedition to see what could be found. As a result of that expedition they formed a company, and in 1670 Charles II granted them a Charter. The name of that body was "The Governor and Company of Adventurers of England trading into Hudson's Bay." To-night you have heard from Mr. Clutterbuck a wonderful story of an adventurer of England, perhaps not trading, but sailing into Hudson's Bay. It is an interesting and remarkable thing that this island of Akpatok, that we have heard about, was first seen in 1610 and then, as far as one knows, it was not seen again until some thirty-five years ago. But in the history of the Hudson's Bay Company there is a similar very interesting and remarkable case. The ships of my Company sailed for nearly two hundred and fifty years past the coasts of Baffin Land, and always as they passed they looked out and the captains and the crews were satisfied that not only was it country on which they could not land, but even if they did land, that it was so barren and so bare that there was nothing they would find there. It is just ten years ago that one of our enterprising post managers asked permission to go and see what he could find there. He spent one winter in great hardship, but the result of his expedition from one point of view was very remarkable, for to-day one of the most prosperous fur-bearing portions of our territory is that which has been looked askance at for two hundred and fifty years.

So far as those areas are concerned, there are great future possibilities. You have read, especially during the past summer, about the development in Fort Churchill and of the trade route from Western Canada, but until the charting of those seas has made progress—and the charting at the present moment is very inadequate—it is always going to be a difficult matter, as any one can tell who reads of the very high rates which the insurance companies are at present charging. In saying that I am not criticizing insurance companies, because it is

at present a high risk which they have to cover. Speaking in the hope that there will be in days to come great development in that area, I trust that before long the charting of those seas will have made very material progress.

I am glad to think that my Company and my men have been of some service to Mr. Clutterbuck's expedition, and it is a pleasure also to know that our men have so much interest in the expeditions which have gone up into those parts. Of course our connection with the Eskimos is largely one of trade. Recently I came upon something that I think would interest you. As you know, we collect the furs from the Eskimos, but in addition to fur-trading the Hudson's Bay Company has large departmental stores, some as big as Selfridge's. The Archbishop of the Arctic told me of something that happened to him in that connection. When in the Arctic one day an Eskimo came to him and brought him a cutting out of a catalogue of the Hudson's Bay Company, which had in some way fallen into the hands of the Eskimo. There was a picture of a beautiful lady, beautifully garbed, and underneath words to the effect that the dress cost ten dollars. The Eskimo told the Archbishop that he had succeeded in saving ten dollars, and would the Archbishop please send the ten dollars to the Hudson's Bay Company and ask them to send him this woman for his wife !

In conclusion, I can promise those who are likely to voyage so far north that if at any time I or my Company can help to forward any expedition, we shall be only too pleased to do so.

Mr. GEORGE BINNEY: Mr. Clutterbuck and I have sailed together on more than one expedition, and we have seen eye to eye on most things, but on Akpatok Island it seems that we differ, for whereas Mr. Clutterbuck has spent a good deal of time in trying to get to Akpatok Island, I, who have also been in those waters of Ungava Bay, have spent a great deal of time in trying to avoid the place. One of the things which seemed to me most remarkable in Mr. Clutterbuck's story was the weather which they experienced on Akpatok Island. I have been on many occasions to Port Burwell, which is only 80 miles distant, and to the Hudson's Bay Company's post in Ungava Bay, and been there, too, at the same period of the year as Mr. Clutterbuck and his expedition, and we certainly never were favoured with the good weather which his expedition found.

One small but rather remarkable point with regard to Akpatok Island is that although it is almost within a stone's throw of the mainland, that is to say, 30 miles or so off the coast of Northern Quebec, it does not come under the government of Quebec but under the government of the North-West Territories. By some ruling not many years ago all the Canadian islands in the sub-Arctic and in the Arctic are under the government of the North-West Territories, and there are thus all kinds of anomalies, such as islands right at the southern end of Hudson Bay or in James Bay, and islands such as Akpatok Island coming not under the government of the territories to which they belong geographically.

Having some experience of the expeditions to the north coast, it strikes me as being very remarkable that Mr. Clutterbuck's expedition—and he has allowed me to tell you this—only cost £1400 from door to door. That is a very small sum for an expedition which has done such good work.

Mr. Clutterbuck spoke of the tides and said that in Ungava Bay they rose many feet. A friend of mine, a fur-trader, who was voyaging from Fort Chimo to Port Burwell, had the misfortune to run aground at the highest spring tide in the middle of Ungava Bay. It was a fairly common occurrence and he took it lightly. He and his companion went down to sleep, saying that they would have to wait for many hours before they could get off; but imagine their surprise when some six hours later they found themselves at least 30 feet above sea-level !

From my knowledge of those waters I am quite certain that the work which

Mr. Clutterbuck has done could not have been done better by members of the Company to which I have been privileged to belong in the past. It has obviously been first-class work which the Oxford Expedition has accomplished in the North.

The PRESIDENT: Mr. Clutterbuck, first allow me, on behalf of this audience, and indeed the whole Society, to offer to you and to the whole of your expedition our very deep sympathy in the loss of one of your companions. We need not go further except to assure you that we know that everything humanly possible was done for him on that occasion.

No one realizes more the necessity and the desirability for the survey both of the coast of Labrador and right into Hudson Bay than we do in this Society. We have repeatedly urged the necessity or desirability of that, and I am not breaking any confidence—there is no confidence about it—when I tell you that the Admiralty are fully conscious of that necessity. You have heard the Governor of the Hudson's Bay Company speak of the Fort Churchill route home. It is of the greatest possible importance. One is inclined to flog one's own horse in order to get along the track, but I know I have personally for years tried to get people to realize how immensely important it is that the grain should go up through Fort Churchill and then have the long sea journey which, of course, is very much cheaper than a long train journey; but those are matters into which we cannot enter now. There is one very remarkable thing about those waters which may not be known to you. It is one of the few places where you get fog and a gale at one and the same time: very unpleasant indeed.

You heard the lecturer speak of Dr. Forbes and his expedition to the north. I do not know what they actually did, but I received a telegram not long ago from Sir Wilfred Grenfell in which he said, "Aerial survey completely successful," and I hope soon that he will send us details of the result. At the moment I do not quite know what has been achieved.

I want to say a word of appreciation of the admirable work your expedition did, Mr. Clutterbuck, under your leadership. We know that your stay was not very long; that you took time to reach the island, and that you had to come back, but during the time at your disposal you carried out some admirable work. You showed slides most interesting to geologists as well as geographers, and I imagine the island must have proved a very interesting place. We congratulate you on the work you have done and the way you stuck to it all through, and also on the lecture that you have given us this evening.

COLOUR PHOTOGRAPHY FOR TRAVELLERS: *Three papers read at the Afternoon Meeting of the Society on 2 May 1932*

I. COLOUR PHOTOGRAPHY IN THE FIELD

CAPTAIN GEORGE SHERRIFF, R.A.

I AM not a technician, and cannot therefore discuss the technical details of the various colour plates on the market. I have however used Lumière, Agfa, and Finlay colour plates in Chinese Turkistan, and propose to talk only about the advantages and difficulties of colour photography for travellers, especially those working in remote places.

The main question to be decided is, whether the value gained from colour photographs is worth the trouble and expense involved in taking them. Let me now put the advantages and difficulties arising in colour photography, and begin with the latter.

My experience is that Lumière and Agfa plates deteriorate rather more rapidly than the ordinary panchromatic plate, such as are used in the Finlay process. I have however successfully used autochromes eight or nine months old, and panchromatic plates a year after their arrival in Turkistan. These were, of course, carefully stored, and the climate is dry. It is damp heat which destroys plates rapidly. A box lined with asbestos, although heavy, is useful for storing plates in a hot climate.

Colour plates require extra care, and in my opinion should be developed as soon as possible after exposure. I carried a very small portable developing box, made by Messrs. Beresford, Albert Bridge Road, and almost always developed my plates the day they were taken. The trouble is not in developing, but in drying plates in a dusty country. In this respect Agfa and Lumière score, as they dry so very quickly. I suppose for the very best results one should use only filtered water, and I have heard some travellers say that they did not take colour photographs because the water was not pure enough. In Turkistan the water contains a good deal of salt and soda, but I do not think that I ever ruined a plate by using it. One must use glass plates, and the packing of the colour plates is perhaps a little more bulky than that of the ordinary plates; otherwise there is no extra weight involved. The greatest drawback of all is the cost; but presumably as colour work becomes more general, the cost will decrease.

The drawbacks do not therefore appear to be very great. Consider now the advantages. There are many subjects which are valuable only for their colour, such as types of human beings, flowers, and animal life. For many of these a black-and-white photograph is almost meaningless. Panchromatic plates have of course improved enormously the monochrome rendering of colour, but, especially in the case of types, flowers, and animals, they leave much to the imagination. Colour photography removes this objection.

Secondly, there is the tendency to stereoscopic effect. I do not know to what extent this is general, but, as I will show you later, some colour photographs show this effect to a marked degree. The formation of ground is exemplified in colour photographs where black and white would be inadequate. It is true

however that atmospheric changes alter the colour of landscapes, and so the advantages of colour over black-and-white rendering of such a subject may not be so marked as at first they appear to be. Such atmospheric changes do not alter the colours of near subjects.

I have used the three processes fairly extensively. I consider the Finlay process much the best. Its advantages are: First, an exposure costs the price of a panchromatic plate. Should that exposure be a failure you lose only the cost of that plate. A failure with an autochrome costs very much more. Secondly, I found Finlay plates to be about twenty times as fast as autochromes. The advantages of this are obvious in taking photographs of human types, animals, and moving objects. From a Finlay negative any number of colour transparencies may be made, as well as lantern slides, enlargements, and contact prints in black and white.

I have, of course, seen beautiful work done with Agfa and Lumière autochromes, and have had good results myself. Of the two, I prefer Agfa, which is faster than Lumière, and is not subject to the green spots, which are due, I believe, to impurities in water used for developing—a thing one must expect when travelling.

Colour transparencies can be shown satisfactorily on the screen. The question arises as to whether they can be reproduced in the *Journal*. Like most things, this is a question of cost.

II. PROCESSES OF COLOUR PHOTOGRAPHY

D. A. SPENCER, PH.D., F.R.P.S.

Colour photography has been available since the beginning of the present century, but it is only within the last few years that the processes have been brought to a point where the production of colour photographs is possible to other than enthusiastic experts. Recent improvements in apparatus, photographic materials, and technique, and extensive research have simplified the photographer's task to so considerable an extent that it is now possible for any one capable of making good black-and-white photographs to record the colour as well as the form of nature. The purpose of this article is to outline sufficient of the underlying principles to enable the reader to appreciate the advantages and drawbacks of the various available systems and to decide for himself how far they meet his requirements.

Additive Processes

There are two practical systems of colour photography—the additive and subtractive. Both are based upon Clerk Maxwell's discovery that practically every colour in nature can be matched by mixing together appropriate proportions of the three "primary colours"—red, green, and blue-violet—obtained by dividing the spectrum into approximately equal thirds.

If a multi-coloured object illuminated with white light is photographed three times through light filters, each of which passes only one-third of the spectrum,

each plate will bear a record of one of the primary colours in so far as this colour is reflected from the object photographed.

Clerk Maxwell showed that when positives from such negatives were projected in register on to a screen, each positive being illuminated by light of the same colour as the filter used when making the parent negative, a close approximation to the colour of the original was obtained.

Since the coloured result is obtained by adding together appropriate proportions of the primary coloured lights this method is known as Additive, and to reduce the system to a practical form which has made its commercial application possible, all three records are made upon one plate through colour filters of microscopic size intermingled in close juxtaposition—the so-called Mosaic Screen Processes.

The Lumière Autochrome is typical of such plates. Three equal portions of potato-starch grains are dyed respectively red, green, and blue-violet. The dyed grains are then mixed together and the mixture dusted on to a glass plate covered with a tacky coating. The surplus grains are dusted off, and those adhering to the glass are flattened out under great pressure, producing a mosaic of microscopic colour filters. Upon this mosaic a panchromatic emulsion is coated, and the resulting plate exposed in the camera with the mosaic nearest to the lens.

If a photograph of a red object is taken upon such a plate, the red rays from the object pass unhindered through the tiny red elements of the mosaic and affect the emulsion, with the result that after development there is an opaque silver deposit exactly underneath each red element. The red rays are however absorbed by the green and blue elements, and the emulsion under these elements is therefore unaffected. The developed plate is now placed in a solution which dissolves out the developed silver image but leaves the unexposed emulsion unaffected. After leaving this bath therefore the plate is transparent under the red elements. The unaffected emulsion under the green and blue elements is now blackened by a second development, and in consequence, when the plate is viewed by transmitted light the latter is only able to pass through the red filter elements.

In the case quoted we have considered the reproduction of a red, which is spectrally simpler than the red of the colour mosaic. The majority of the colours are of course more complex than this, and varying proportions of the constituent rays will pass through all three elements, producing varying degrees of opacity behind these elements which, after the reversal process, become varying degrees of transparency allowing appropriate proportions of each of the three colours to pass. These are blended on the screen or confused together by the eye to reproduce the original colour.

All mosaic screens are based upon the same general principles, differing from each other chiefly in the methods by which the mosaic is produced.

The Lumière Autochrome, the first commercially successful mosaic, is now available on either glass plates or as cut films. The exposure required is about sixty times as long as an ordinary plate (H. & D. 250), and snapshot exposures are therefore only possible in tropical countries or at midday in midsummer in England. It is still considered by many to be the most satisfactory screen plate.

The mosaic in the Agfa colour plate is built up of coloured gum particles

instead of starch grains, and the plate requires less exposure than the Autochrome. Successful landscape photographs have been made in England with exposures of one-twentieth second and a lens working at f/2·9.

The mosaic in the Spicer-Dufay film is a geometrical one made by printing coloured lines at angles to one another on a cellulose ester base. The process is at present confined to colour cinematography, but the material is shortly to be available as film for use in ordinary cameras. Although the transmission of each filter unit is more nearly one-half of the spectrum than the usual third, the truthfulness of colour rendering appears in no way inferior to the older types of mosaics.

This extension of the filter transmission not only shortens the exposure required, but results in a relatively larger proportion of the incident light reaching the screen when the film is projected.

The Finlay process differs from the Autochrome and Agfa in that the colour screen is independent of the actual photographic negative. After the latter is developed any number of colour positives can be made from the negative by the normal methods of lantern-slide making. When the mosaic and emulsion remain throughout on the same support there is a loss of saturation on copying, and consequent definite falling off in quality, and where more than one copy of the subject is required the Finlay, which avoids this difficulty, is probably the best process.

The Kodacolor process, at present confined to 16-mm. cinematography, is described later by Mr. Phillips. When ample light is available for exposure the colour rendering is the most beautiful of any colour cine process yet available. A satisfactory method of copying the original is still required.

Subtractive Processes

In additive processes we start with a dark screen and build up a picture by adding together coloured lights. In nature, substances are not coloured in this way, but instead they absorb or subtract certain portions of the visible spectrum of white light and reflect the remainder. This composite reflected portion is the colour the eye perceives as the natural colour of the object.

In subtractive processes we start with white light, represented by a sheet of white paper, and subtract from it the unwanted radiations. The printing colours used are therefore white minus primary red, *i.e.* blue-green; white minus primary green, *i.e.* pink; and white minus primary blue, *i.e.* yellow.

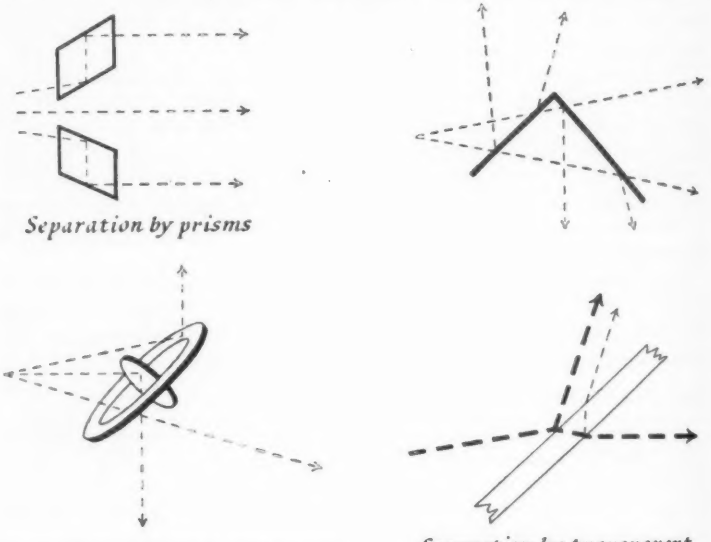
The difference between additive and subtractive colour photography is like that between modelling and sculpture. The modeller starts with an empty pedestal and adds clay to it in appropriate shapes until his model is complete, whereas the sculptor starts with a block of marble and chips away unwanted material until the figure is complete.

All subtractive processes require three negatives of the subject exposed either simultaneously or in rapid succession through the three primary colour filters. It is the difficulty of obtaining these negatives which is the greatest drawback to the subtractive processes, and for landscape work the following methods are the only ones at present available.

The simplest method is to use an ordinary camera and expose the three plates in succession. This method demands that, even under ideal lighting

conditions, the subject remains still for at least twenty seconds. Nevertheless, the majority of separation sets are made in this manner, and when the weight of the outfit must be kept to a minimum excellent work has been done with the Leica camera which uses cinematograph film as negative material.

A repeating back on an ordinary camera is a dark slide holding three panchromatic plates with a colour filter in front of each. The three exposures are made by moving the back over by hand between each exposure and the minimum time required for open-air work is approximately seven seconds under midsummer conditions (Autotype Back). The back can also be arranged to bring each plate into position by gravity fall, operated by an Antinous



Methods of dividing up light in a one-exposure camera

release (Uvachrom Back). The total exposure in this case is less than with the hand-operated back, but not to an important extent.

With one-exposure cameras all three plates are exposed simultaneously, the light from the lens being divided up inside the camera by an arrangement of prisms or mirrors which divert appropriate fractions of the light to the three plates. There are two general methods of accomplishing this, illustrated diagrammatically in the figure.

The disadvantage of type 1 is that since different portions of the lens are used to form each image, stereo-parallax is produced, and it is extremely difficult to make the final print register when, as in landscape, there is any appreciable depth of field.

In type 2 transparent reflectors are used to divert some of the incident light on to two of the plates. In this case the whole of the lens is contributing to the formation of the image and stereo-parallax is absent.

Unfortunately these cameras usually suffer from refraction errors, and since the amount of light reflected from the glass surfaces depends upon the angle at which it strikes there is a falling off in illumination across the plates. Both these difficulties can be minimized by careful design, and type 2 is probably the most satisfactory for the landscape worker.

It is possible to consider an additive transparency as an original and photograph it three times through the three filters. Unfortunately the prints eventually obtained are not so truthful or pleasing as a straightforward separation set. When an Autochrome is to be reproduced as a three-colour half-tone illustration this degradation is not necessarily important, since the reproduction process in any event involves extensive retouching of the printing blocks. Unfortunately the need for retouching makes the truth of colour rendering entirely dependent upon the block-maker's skill and knowledge of the original. Moreover, block-making is so costly that it is only justified when some thousands of prints are required.

There are two practical methods for making small numbers of paper prints from separation negatives.

The Carbro process involves making bromide prints from the separation negatives and using the silver in the surface of the prints to harden, by appropriate chemical treatments, pigmented gelatine plasters brought into contact with them. These plasters are treated with warm water to dissolve away unhardened, unwanted gelatine, and the residual hardened images (pink, yellow, and blue) are assembled in register on a sheet of paper.

Although the Carbro process in the hands of a skilled worker is capable of giving excellent results, considerable experience is necessary before the best results can be obtained. The Vivex process of Messrs. Colour Photographs (B. & F.), Ltd., is, in its broad essentials, similar to the Carbro process, but the operations have been modified and standardized and the conditions under which the prints are made have been brought under exact control. As a result, it is possible to obtain the best possible result from each separation set with a minimum of wastage and expense.

Since standardization of the process involves the control of voltage, temperature, and humidity at each stage, the process can be worked only under factory conditions.

Apart from the fact that prints by the Vivex process are the most truthful in colour rendering of the existing subtractive colour processes, the advantage from the photographer's point of view is that his task is confined solely to producing the separation negatives.

From the point of view of the traveller the additive processes have the advantage of simplicity. They are probably the most truthful as regards colour rendering, but, as in all colour work, only the most careful technique will produce pleasing results. One is limited to transparencies, and usually duplication of results is unsatisfactory.

The subtractive processes give any number of results on paper, and if use is made of the available printing services the photographer need only acquire the technique of making the necessary negatives. The methods at present available for making these negatives present a certain amount of difficulty to the traveller, particularly with subjects necessitating snapshot exposures.

III. THE KODACOLOR PROCESS

F. B. PHILLIPS, B.SC.

The production of motion pictures by amateur photographers has been largely made possible by the introduction of sub-standard 16-mm. film and the reversal process. In this process the film exposed in the camera is developed and the resulting negative image is at once bleached out by a suitable silver-solvent. The residual silver bromide then goes to build up a positive image of suitable projection density, so that finally the original film which passed through the camera is ready for use in the projector.

The Cine-Kodak consists of a hand camera containing room for 50 or 100 feet of cinematograph film 16 mm. wide, together with a clockwork mechanism for moving the film intermittently between the exposures. The photographer has only to load the camera and expose the film, altering the stop and the focus as necessary. Finally, he sends the exposed film to a Kodak processing station, where it is treated as already described and returned ready for projection.

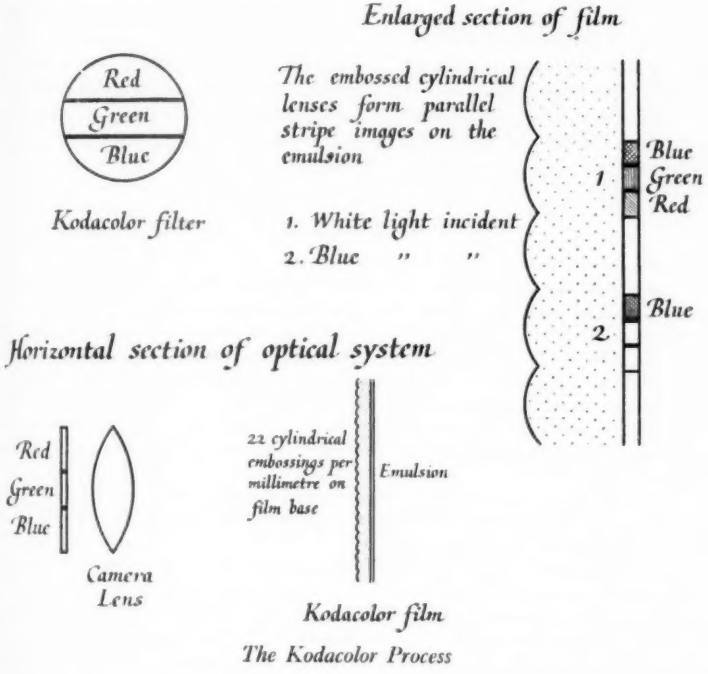
The Kodacolor process enables the photographer to take his motion pictures in natural colours with equal ease. All that he has to do is to place a tricolour filter in front of his lens and load the camera with a specially prepared film. The circular filter is divided by two vertical lines into three coloured zones which transmit the red, green, and blue-violet portions of the spectrum respectively. It is necessary that all exposures should be made at one aperture, f/1·9, and provision is made whereby the lever which alters the aperture cannot be moved while the Kodacolor filter is in position.

A noteworthy thing about the process is that there is no colour on the film itself when viewed after development and reversal. There is only a black-and-white image on a transparent base, the back of which is embossed with a series of parallel cylindrical corrugations running from top to bottom of the picture. Twenty-two of these cylindrical embossings occupy 1 millimetre, and the film is threaded into the camera so that the light is incident on the corrugations and passes through the thickness of the film base before reaching the sensitive panchromatic emulsion.

The diagram shows the optical system of the camera with the filter placed in front of the lens and the Kodacolor film with its sensitive surface at the back. It should be remembered that the corrugations themselves are so small that in the ordinary way the lens would photograph any object in front of it without any appreciable distortion. Let us imagine the filter placed in position and illuminated with white light. Each embossing of the film base will act as a cylindrical lens and will project on to the emulsion an elongated image of the

filter consisting of three parallel coloured stripes: red, green, and blue-violet. There will thus be on the back of the film a series of parallel lines divided into triplets.

If the filter were illuminated by red light, the green and blue segments of the filter would transmit no light, and thus only the first member of each triplet would be formed, the other two spaces remaining blank. Similarly, if the filter were illuminated by green or blue light, only the green or blue member of the series would form a stripe on the emulsion. But when composite light is incident, then the stripe images are formed of triplets of which the three members vary in intensity according to the colour-composition of the original



The Kodacolor Process

light. When therefore an exposure is made on any scene, the image formed by the anastigmat lens is broken up into its line elements according to the colours reflected from the different parts of the scene. The reversal process will give us a positive black-and-white image, as already described, and the lines will be transparent or opaque according to the presence or absence of light of the particular colour registered by that position on the emulsion.

Now in an optical system the paths of light-rays are reversible: that is to say, if light, in passing through any reflecting or refracting system, suffers a certain series of deviations when travelling from left to right, then if it is sent back along its own path in the opposite direction it will suffer the same series of

deviations in the opposite sense, finally emerging from the system exactly as it originally entered.

When therefore, as in the diagram above, white light is allowed to fall on the emulsion side of the film, passing from right to left, it will penetrate the transparent lines into which the black-and-white image is broken, and will be stopped by the opaque ones. Continuing to retrace its path it will, by the principle of reversibility, finally emerge through that coloured filter section through which came the corresponding incident rays.

This is the principle on which rests the projection of Kodacolor film. The film is threaded through a Kodascope with the emulsion side of the film towards the light, and a filter similar to that used on the camera is placed over the projection lens. A specially prepared aluminium-sprayed screen is erected and the picture projected in colour. The manipulation and skill required of the photographer have been reduced to a minimum, and the production of motion picture films in natural colours has been rendered surprisingly simple. As the process is becoming better known among travellers, it is gradually coming more into use for the production of motion-picture records in colour which would be otherwise practically unobtainable.

DISCUSSION

Before Captain Sherriff's opening remarks the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: We make progress. Reading from that most entertaining book of Dr. Mill's I find that the proposal to illustrate papers read at the evening meetings by the lantern slide was scoffed at by some of those who said that it would lower the Society's discussions to the level of a Sunday school treat with the magic lantern. Slides were, in fact, first introduced surreptitiously, and were received with such enthusiasm that in 1890, by a dexterous suggestion that projections from a dioptric lantern would enhance the scientific value of the meetings, formal consent was given to the purchase of a lantern, and a great step forward was taken.

When we can welcome here an afternoon meeting on colour photography for travellers, and have people with various experience to explain their methods to us, we may say that we progress.

Captain Sherriff, whose beautiful photographs are to be seen now in our photographic room, will start the discussion, and after that Dr. Spencer, who is the Joint Hon. Secretary of the Colour Section of the Royal Photographic Society, will describe some technical differences between the processes and show some results, and then Mr. Phillips, of the Kodak Company, will explain some exhibits, and project on a special screen some films in the Kodacolor process.

After Mr. Phillips's description and demonstration of the Kodacolor process the PRESIDENT said: Captain Sherriff said that he was not a technician; nor am I. I am not even a photographer, but I am sure you will join with me in saying that we have had a most interesting and useful afternoon. I remember that Sir Henry Jackson, some years before his death, told me that he thought that colour photography was a more wonderful discovery than wireless. I leave it to you and others to say whether that statement was justified or not. In Dr. Mill's book, which I quoted at the beginning, I find that Sir Francis Younghusband, in his Presidential Address to the Society, claimed a high place for geography in the study of natural beauty, and said that for complete geographical description the scenery must be appreciated in its form and colour and its effect on the observer. Only two nights

ago I heard the President of the Royal Academy speak of photography as being complementary to, not competitive with, the art for which the Royal Academy stands. No one need have any fear that we are trying to obtain an unfair advantage either of Nature or science by adding to the charm of our lectures and other demonstrations here by means of colour photography when we can. It is not given to everybody to depict the beauties which he sees when he goes on travel, though it is quite true that even here in our small collection we have some very lovely water-colours and pastels done, for instance, by Dr. Wilson in the Antarctic; and if you read such a book as Valentine Chirol's 'Pen and Brush in Eastern Lands,' you will find some admirable water-colours. But that accomplishment is not given to everybody. It is given to everybody however to appreciate these beauties and display them to others. I do not know whether such a thing would ever be possible as to put in colour that marvellous description of Nansen's 'Arctic Night,' but at any rate, whether possible or not, it is something to aim at, and we can watch with interest these gentlemen who spend so much time and care and trouble in perfecting both their instruments and scientific research, and give them the best possible thanks for what they do to increase so largely the pleasure that may be obtained both from travel and from its description afterwards.

I do not propose that there should be any formal discussion now, as the hour is rather late, but the gentlemen who have spoken will remain for a time to answer any technical or other questions which you may like to put to them. In the meantime I ask you to join with me in offering to them our sincere thanks for a very enjoyable afternoon.

A MINOR ADJUSTMENT IN THE BOUNDARY BETWEEN TANGANYIKA TERRITORY AND RUANDA

J. B. LAWS

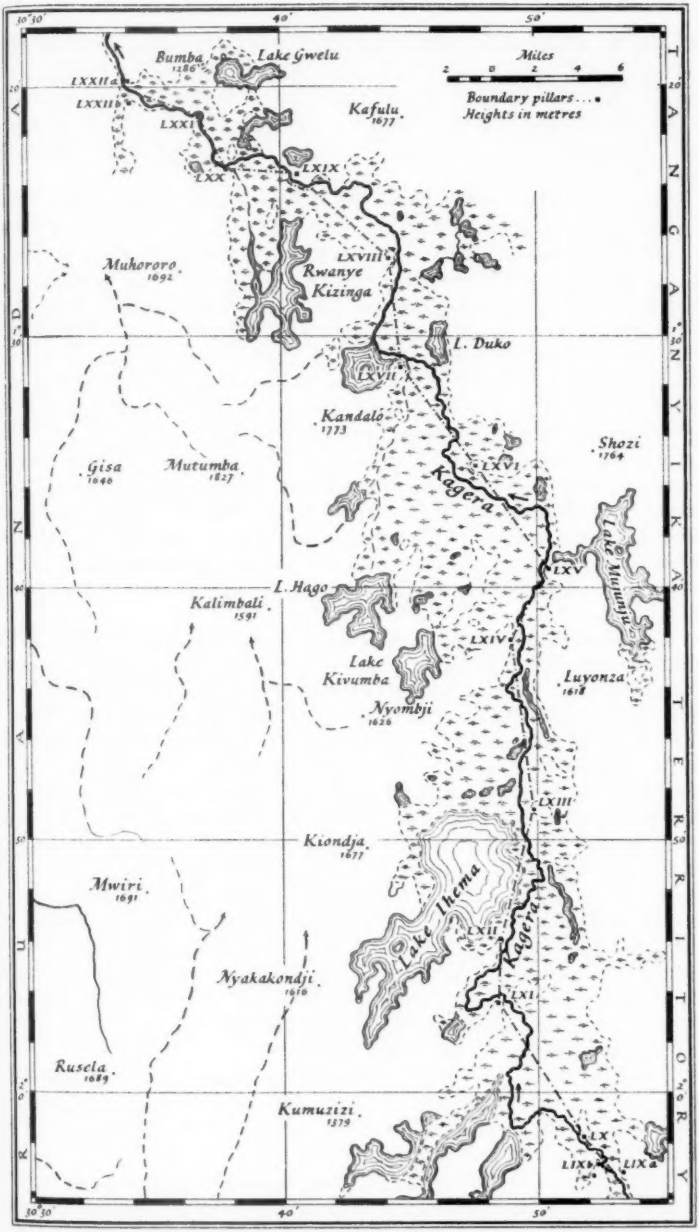
THE country which was German East Africa is now divided into two parts—Tanganyika Territory under British Mandate, and the provinces of Ruanda and Irundi under Belgian Mandate. The boundary between them is defined by a Protocol signed at Kigoma on lake Tanganyika in August 1924. In its northern part this boundary follows for 120 miles the course of the Kagera River, the largest affluent of Victoria Nyanza, and is defined in the Protocol as the *Thalweg*, or line of greatest depth, of that river. For more than half this distance the Kagera flows through wide papyrus swamps, and its tortuous and variable course makes it of little use as an international boundary if the areas which it divides are of any economic importance. Provision was therefore made in the Protocol whereby local representatives of the Governments concerned might effect alterations in this part of the boundary if it became necessary to do so.

By the year 1930 the exploration of the Ankole-Karagwe tinfield, which here extends into Uganda, Ruanda, and Tanganyika Territory, had progressed far enough to show that tin dredging operations might be undertaken in this part of the Kagera valley and that a more definite and permanent boundary than the *Thalweg* of the river would then be required. In that year the writer carried out a reconnaissance of the boundary between latitudes 1° 20′ S. and 2° 5′ S. to find out whether it would be possible to demarcate that part of the boundary by a series of intervisible stone pillars built on islands or promontories in the swamp. It was hoped that the new boundary, running straight from pillar to pillar, could yet be made to follow the same general course as the river, and thus avoid any serious territorial changes.

Following this reconnaissance the Provincial Commissioner then in charge of the Bukoba Province of Tanganyika, who, as British Commissioner, had signed the Kigoma Protocol in 1924, was asked by the Tanganyika Government to meet the Belgian Government's representatives at the Kagera and to reach an agreement with them as to the exact line which the new boundary should follow. When this had been done he was to collaborate with them in establishing the necessary pillars. The writer accompanied the British Commissioner as technical assistant. The Belgian Representatives were M. le Resident de Ruanda and M. le Chef de la Mission Cartographique de Ruanda-Urundi, and our first meeting with them took place at Kyerwa, a mining camp on the Tanganyika side of the Kagera River and at the northern end of the area in which our work lay.

The demarcation of a satisfactory boundary line through such country as the swamps of the Kagera presents many difficulties, and it was only through the spirit of cordial co-operation and goodwill with which the Belgian representatives approached each problem that we were able to reach a wholly satisfactory agreement, both as to the line that we should demarcate and the way in which it should be defined.

Having reached this agreement the Belgian Representatives re-crossed the



Revised boundary line between Tanganyika Territory and Ruanda

Kagera River and proceeded southwards, building as they went those pillars which we had agreed would be required on the mainland of Ruanda or on islands close to the Ruanda shore of the swamp. At the same time the British Commissioner and I, after visiting the extreme northern end of the swamp, also marched south, building the pillars that were needed on the Tanganyika side of the river.

The area in which we were working is one that has been subject to relative subsidence in recent geological times. The main valley of the Kagera is flooded to a width of from 5 to 8 miles, whilst tributary "drowned valleys" penetrate as far again into the surrounding country. The greater part of this flooded area is covered by papyrus which rises 8 or 10 feet above the level of the water; but there are many sheets of open water and in the tributary valleys acres of stagnant water are completely covered by a pink water-lily. On my first visit to the area I was fortunate enough to see these in full bloom. Elsewhere deep water is covered by a curious carpet formed of a short, coarse-leafed reed growing out of and binding together a mass of decaying vegetation only a foot or so in thickness. It is in such places as these, which from a distance look like meadows, that the "sitatunga' (*Tragelaphus Spekei*) is almost always to be found. This most interesting member of the bushbuck family has become wholly adapted to living in the swamps and comes to dry land only at night. They may be seen from a distance without difficulty, but are almost impossible to approach, and they are killed by the natives only by means of organized drives.

The native population in this part of the Kagera valley is limited to a few scattered villages of Banyambo, cultivating bananas along the margin of the swamp. On the Tanganyika side of the river the spread of the tsetse fly has now confined domestic stock to a few islands and to the extremities of one or two peninsulas running out into the swamp; these places, cleared of all bush and undergrowth, afford the only refuge from the fly. It was on such places that the boundary pillars were to be built, and here occurs one of the difficulties of replacing a natural boundary by one that is artificially marked on the ground. The boundary pillars must be built on firm ground above the level of the swamp, and if the boundary is to run straight from pillar to pillar, then at each pillar built on the British side of the river the piece of ground lying between the pillar and the margin of the swamp will become, technically, Belgian territory; in the same way, when the pillar is built on the Belgian shore, a similar piece of ground will become British. Since in many places the shore of the swamp slopes gently to the water's edge it is necessary to build the pillars some distance inland to ensure that they are intervisible, and the piece of ground thus cut off becomes of considerable size.

In order to avoid this difficulty the new boundary has been defined as following the straight line between pillars only so far as that line passes over the swamp; where the line, approaching a pillar, reaches the margin of the swamp the boundary follows that margin until it is again cut by the straight line joining the next pair of pillars. The boundary is thus made up of a series of straight lines linked by short stretches of the natural boundary formed by the margin of the swamp. The definition is cumbrous, but it not only meets the difficulty inherent in the substitution of a partly artificial

boundary for one that is wholly natural; it also serves the purposes both of the natives and of the European companies exploiting the tin deposits. The indigenous natives are given the assurance that the whole of the one bank of the swamp and certain islands are British Territory whilst the remainder of the islands and the other bank of the river are Belgian; the imaginary straight lines cutting through the swamps do not concern them, since the river and lakes are freely accessible to the natives of both banks for fishing or for navigation. On the other hand, the line joining the intervisible pillars provides for the owner of a mining concession a permanent boundary which he can re-establish at any point when it is required.

The building of the boundary pillars and the fixing of their positions on the existing maps of the area occupied both parties for five weeks. At the end of this time we rejoined the Belgian representatives in Ruanda at the southern end of the area through which we had come. Here we drew up a draft agreement defining the boundary in the way that I have outlined above; the agreement was signed by both parties on 11 July 1931, and has been submitted through our respective Governments to the League of Nations.

EARLY MAP INDEXING

EDWARD HEAWOOD, LIBRARIAN R.G.S.

SIMPLE as it may seem when once thought out, the common method of indexing maps by a conventional system of co-ordinates defining the positions of places upon them did not, it seems, suggest itself to geographers until some time after the printing of maps had come into vogue. It may therefore be worth while to put on record an early, possibly the earliest, instance of its adoption—in the mid-sixteenth century—particularly as its author was a man to whose concern with geography little attention has yet been paid.

In quite early days the need of some handy guide to the location of places on the map had naturally been felt, and the geographical co-ordinates of places given by Ptolemy in his lists might serve the purpose, provided it were known in what country the place in question was situated (the arrangement being regional throughout). Failing this the seeker would be helpless, and the next step was the compilation of an alphabetical index to the whole geography, which was done in an imperfect way by the early editors in the fifteenth century. The *Registrum Alphabeticum* of the early Rome editions took count of the first letter only of the names, the arrangement within the initial-letter groups being quite haphazard; the references were to the book and chapter of the text, and to the number of the map in which the places were spoken of or shown. The editor of the Ulm edition of 1486 explained to the users of his similar index that, having turned up the relevant passages in the letterpress, the co-ordinates there given would enable them easily to find the places on the maps named in the index. The Strassburg edition of 1513 made things a little easier by taking count of the second letter also of the names, a guide being

supplied at the head of each column by printing the initial letter of the names therein, followed by such second letters as occurred in that column*; the references were here to the several columns of the text. Still, no direct indexing of the maps was attempted until some forty years later, when it was done for the Basel edition of 1552 (known to bibliographers as Münster's fourth) by the German grammarian Conrad Wolfhart, known also under the Grecized form of the name, Lycosthenes. His name appears on the title-page as author of the index, but the lines referring to this have been either omitted by bibliographers or copied without comment, obscuring the fact that a new system of indexing was here brought into use. (In the Society's copy of this edition the freak of a former owner has entirely masked the authorship of the index, the names both of Münster and Lycosthenes having been carefully expunged wherever they should appear: possibly religious animosity was the reason, for a statement about the religious superstition of the Spaniards has also been expunged.)

Besides the index itself Lycosthenes gives an introductory section in which he descants on the use of maps as making travel possible (in a sense) for the stay-at-home without the hardships and other drawbacks of actual journeys, and goes on to explain the use of the index. This is in two parts, the first containing the Ptolemaic names, the second those in the modern maps. As Münster had marked the geographical co-ordinates in the margins of the ancient maps, the references in the first part were to these. For the modern, which either lacked the degree-notation entirely or gave it for the latitude only, Lycosthenes says that he had been forced to supply an arbitrary graduation "extra omnem poli altitudinem," and explains how places can be found at once by its help, preferably in conjunction with a similarly graduated ruler held across the map. On examining the modern maps we find that the graduations (always 24 for the length, 18 for the breadth) have evidently been printed from separately engraved strips. As the names were arranged in strict alphabetical order (apart from a few obvious slips) this index was certainly an advance on those of previous editors.

The 1552 Ptolemy was not the only book to which Lycosthenes applied his method. In 1560 he was concerned in the reprint of the brief description of Switzerland by Aegidius Tschudi, originally printed by Münster in 1538 to accompany Tschudi's big map of Switzerland. In 1538 the index gave references to the text only (by page and line), but in 1560 Lycosthenes added another in which rectangular co-ordinates were used to define the positions of places on the map, itself also reprinted. It bears a marginal graduation of 80 divisions each way (spoken of as "gradus"), and has also a long note by Lycosthenes explaining once more the use of the system. This re-issue is generally thought to have been from the original blocks, and as there is nothing to indicate the graduation as an addition, one might suppose it to have been present either in Tschudi's original MS. or in Münster's issue in 1538, now unknown. Yet the booklet uses no such means of reference, and if the figures had been placed there for the purpose in 1538, Lycosthenes could hardly have claimed the

*In Servetus's Edition of 1535 the second letters were printed in the margin at the points where they began to appear; and it is interesting to find a further help given (as in some modern books of large format) by denoting the upper, middle, and lower parts of the page by the letters a, b, c.

method as his own in 1552, unless indeed his claim refers only to the labour of compiling the index, which must in any case, it seems, be placed to his credit. It is perhaps unlikely that so big a map should have been re-engraved only twenty-two years after its first issue, though similar cases are not unknown.

The letterpress on the Tschudi map of 1560 speaks of other maps for which Lycosthenes had previously made indexes, and this may throw a sidelight on some obscure points in sixteenth-century cartography. Three maps are mentioned besides those in the Ptolemy, which are put last and introduced by the word "nachmals" (afterwards), showing that the other indexes had been made before 1552. The first map is the Holy Land of Orontius Finaeus, now quite unknown. Although its author speaks of it as in course of being engraved in 1536 (Bagrow: 'Catalogus Cartographorum,' I, p. 66), doubts have been expressed as to whether it ever actually appeared. The second is Heinrich Zell's map of Germany, also unknown in its original issue, the date of which is doubtful. The earliest undoubted issue is of 1560, and this shows a close resemblance to a map by Gastaldi of 1552, raising a question of priority between the two cartographers (Bagrow, *op. cit.*, II, p. 112). If however a map of Germany by Zell had been indexed by Lycosthenes before 1552 the point would be definitely settled in Zell's favour, in accord with general probabilities. The third map mentioned is Caspar Vopel's world-map, of which again the earlier versions are unknown. We learn from the cartographer himself (Bagrow, II, p. 94) that it appeared in 1545, and there are references to issues of 1549 and 1552, the former being spoken of as "in magna forma." In 1570 a new version was brought out at Antwerp in twelve sheets, and that the original map was a large one is confirmed by the epithet *herrlich* applied to it by Lycosthenes. We are not aware of any other mention of this writer as concerned with the above three maps, and it may be that his indexes were produced independently, and that the positions were given by geographical (not conventional) co-ordinates; otherwise they would be useless without a marginal graduation on the maps themselves, which the later issues, apparently, do not possess. But his claim that they had proved useful to geographers seems to show that they were actually published in some form or other.

It may be recalled that a grid with marginal numbers and letters for purposes of reference was used in this country before the end of the sixteenth century by John Norden for his county maps.

THE ITALIAN EXPEDITION TO THE HIMALAYA, KARAKORAM, and Eastern Turkestan (1913–1914). By FILIPPO DE FILIPPI. *London: Edward Arnold & Co.* 1932. 10 × 7½ *inches;* xvi + 528 *pages; illustrations and maps.* 50*s*

THIS book is a mine of information. It has been worth waiting eight years to get an English translation. It is more than a translation, for the text has been thoroughly revised, and a chapter has been added on the scientific results. It is a scholarly work, containing the best bibliographical notes and references yet published on this region. We have to go back to 1875 and Drew's 'Jummoo and Kashmir' to find a comparable volume. Yet the narrative exhales the very air of Ladakh, and the enduring spaciousness of travel and sojourn in High Asia. The translation is extremely well done. The successful conversion of the place-names from the Italian into the recognized English spelling has involved great care and labour. The reviewer can only find one misprint. On p. 320 Vigne's date is given as 1873 instead of 1837. The General Index is full, and the separate Bibliographical Index quite invaluable to every one interested in the region, constituting a complete bibliography of the literature of the Eastern Karakoram, Ladakh, and Baltistan, together with much of that of Chinese Turkistan.

The book falls naturally into three parts—Baltistan and Ladakh, the Rimo glaciers, and Chinese Turkistan. It is arranged almost on the plan of a series of articles, each complete in itself, but connected together by the thread of travel. After a survey of the origin and organization of the expedition, we are quickly taken through Kashmir into Baltistan. Chapter III describes a winter in Skardu, and Chapter IV, by Professor Dainelli, winter excursions into little-known corners of Baltistan. Dainelli is emphatic that the Baltis, although speaking Tibetan, do not possess Mongolian characteristics. He made some three hundred measurements, and separates the Balti type altogether from the Brokpas and Dards of the Indus. The whole expedition left Skardu for Leh in February (1914), snow being often troublesome, though frozen portions of the Indus in some places made the route easier than in summer. A very beautiful panoramic view of Lamayuru is published opposite p. 142, and the whole of this chapter (VI) is lavishly illustrated. Two more chapters (VII and VIII) by Dainelli follow, Chapter VII dealing with two almost unvisited sections of the Indus valley. The ethnology of the Brokpas and Purigs is discussed, and there is a good account of the castle of Chiktan, the interesting stronghold of the ancient Dard princes of Purig. Chapter VIII describes winter visits to Rupshu, Lake Pangkong, and the Zanskar Valley. But is it really certain that the morphology of the Pangkong Lake is due to glacial excavation and not to irregular subsidence (pp. 267–8)? In Chapter IX Sir F. De Filippi describes the journey up the Shyok Valley to the Depsang Plateau. Here again the illustration of the route surpasses that of any previous publication; the photographs of the great peaks of the Nubra–Shyok divide will be of particular interest to mountaineers.

Owing to the almost complete absence of feed about the Rimo and the sources of the Yarkand river, it is impracticable to explore this country with horses. De Filippi therefore sent his animal transport back as soon as he had dumped all his stuff on the Depsang plain, from henceforth depending entirely on coolie transport, and that necessarily reduced to the lowest possible numbers. After a description of the establishment of the base on the Depsang plain, with some account of the meteorological and physical observations carried on there, we begin the exploration of the Rimo glacier. This is illustrated by eight very fine

panoramas in a pocket at the end of the book, which, with the map, enables the reader to follow in detail this fine piece of exploration: the complete delineation of the last great glacier system of the Karakoram then remaining unexplored, and one of the main objects of the expedition. The Italian success was certainly complete, and this despite very bad weather. There was great delay over the survey work owing to continued snowstorms on the upper Rimo, and De Filippi bears generous testimony to the devotion to duty of the surveyors, Jamna Prasad and Shib Lal. In Chapter XII Dainelli describes a dash to the Lingzithang, a visit to the Aqtash and Kumdan glaciers, whose recent advance again has once more dammed up the waters of the upper Shyok, and his visit to the Rimo source of the Yarkand river. In some ways the most startling geographical discovery of the expedition was that the source of the Yarkand river is a tongue of the Rimo glacier which overflows northward across the water-parting, and it is typical of the competence of the membership that the leader's main Rimo survey party, Wood and Spranger's northern survey party, and Dainelli's small caravan, all independently made this same discovery one after the other. Chapter XIII is contributed by Spranger, and describes the exploration, with Major Wood of the G.T.S., of the sources of the Yarkand river. It was these explorations that led afterwards to Professor Mason's expedition. Chapter XIV sums up the topography of the Rimo and the sources of the Shyok and Yarkand rivers: not only is very full acknowledgment made, in the historical portion, to the work of previous travellers, but a line-map showing Dainelli's Siachen-Rimo traverse of 1930 is added to bring information right up to date.

Chapters XV to XVII form a third portion of the book, dealing as they do with the Karakoram, Suget, and Kökart passes; the Raskam Darya, where further exploration was stopped by the flooded river; and the journey from Surkowat to Kashgar and thence to Russian Turkistan. Chapter XVII contains an interesting résumé of the historical vicissitudes of Turkistan. It is pleasing to find it recorded (p. 479) that Kishen Singh's determination in 1873 of the longitude of Kashgar agrees almost exactly with that obtained from wireless by De Filippi. So remote and isolated are these regions that it was not until September 30 that the expedition received details of the opening phase of the Great War. They had received news on August 16 that war had broken out, but that Italy and England were not involved: nevertheless Alessio, Antilli, and Alessandri had felt compelled to return to duty, and left the expedition. The War brought the expedition to a premature close, though Abetti and Ginori completed the geophysical work at Tashkent, closing the series of stations commenced at Dehra Dun. For the benefit of English readers unable to tackle the *Relazioni Scientifiche* it may be said that the closing chapter on the scientific results is disappointingly brief. Yet the feat of compressing into 500 pages the narrative of such a journey, so long and so fruitful in results, compels admiration.

A charming feature of this book is the author's attitude to previous travellers. So far from endeavouring to enhance his own achievements by depreciating, or omitting reference to, the work of his predecessors, he goes out of his way to draw attention to them: a generosity by no means universal amongst travel writers of any generation. The same note is struck by his praise of Petigax; by his appreciation of Rasul Gulwan—"the ablest, most upright and companionable *caravan-bashi* that ever was"; by his care of and gratitude for the services of his coolies, both Baltis and Ladakhis; and by his care for his horses (p. 304). Italy has every reason to congratulate herself on the uniformly favourable impression left behind by the great Italian expeditions to the Himalaya. They have the art of travel; and a large part of that art consists in getting the best out of the native population, a result entailing the exercise of unlimited patience, combined with

a regard for local prejudices which it is sometimes not easy for the traveller to produce perpetually. Particularly in Dainelli's more ethnological contributions to the book do we see the essential value, to the traveller who would understand what he sees, of sympathy with the people of the country.

Throughout the book there is a wealth of illustration. The frontispiece is a good reproduction of a beautiful painting by R. W. Spranger, which, though made from a photograph, successfully recalls the upper Shyok flowing clear and placid in spring, before the melting of the snows has transformed it into a malevolent flood. The second coloured plate, of the lake discovered by Hayward in 1868 near the source of the Yarkand river, is a welcome introduction to the second part of the book. But it must be noted with regret that Antilli's beautiful photographs in the text have been massacred by the English publisher. Fortunately the panoramas were printed in Milan, and leave nothing to be desired. Nothing could be better than "Lamayuru," at p. 142, an Italian reproduction; while Dainelli's arresting picture of the Castle of Chiktan, on p. 243, is ruined by bad English reproduction. But, poorly reproduced as they are, the text illustrations form a very fine series and add enormously to the value of the book both for the specialist and for the general reader. For the glorious panoramas, seven in the text, and eight of the Rimo glaciers in a portfolio at the end, no praise is too high. As the scope of exploration becomes more limited it must become more intensive in method. Complete illustration of the country becomes more and more desirable in the published report or narrative. In combination with the maps these panoramas mark a standard of excellence for the emulation of future travellers.

There is a useful general map of Kashmir, from Lahore and Pindi up to Kashgar and Andijan, which shows the enormous length of route travelled by the expedition, and makes it quite easy to follow the numerous and interesting side excursions of subsidiary parties, extending all through Baltistan and Ladakh to Rupshu and the Aqsai Chin. But the main achievement of the expedition is the map on the scale 1 : 250,000 of the Rimo glaciers, and of the sources of the Yarkand river. The former enabled Professor Dainelli, in 1930, to make the first crossing of the main Karakoram axis east of the Muztagh Pass, from the Siachen to the Rimo; and the latter, the exploration and mapping of the three western upper tributaries of the Yarkand river offering the possibility of approach to the Shaksgam, was the mainspring of Professor Mason's expedition of 1926. The delay in the publication of an English edition has enabled De Filippi to incorporate references to these later expeditions, including that of H.R.H. the Duke of Spoleto, when (1929) Colonel Balestreri succeeded in joining Sir Francis Younghusband's farthest point with that reached by the late Major Minchinton, of Mason's expedition. Thus, by a fortunate chance, the English edition is of even greater value and interest, both to geographers and mountaineers, than the original Italian edition.

T. G. L.

REVIEWS

EUROPE

THE MAP OF ENGLAND: or, About England with an Ordnance Map. By Col. Sir CHARLES CLOSE. *London: Peter Davies* 1932. $7\frac{1}{2} \times 5$ *inches;* x + 166 *pages; illustrations.* 6*s*

In this little volume Sir Charles Close has given us a very readable account of the maps of England, starting from the earliest times, but with particular reference to the productions of the Ordnance Survey. He writes in a pleasantly humorous and discursive style. The book should do much to awaken the uninformed to the extraordinary wealth of information that there is in our national maps, to those who have the eyes to see and the intelligence to comprehend. It is a lamentable fact that in these days of universal education the map is still to so many a sealed book, or at best merely an aid to getting from one place to another. Sir Charles shows how it can be, and in this country definitely is, a compendium of information; how, besides giving a vivid picture of the ground, it is full of instruction in the history of the country. He shows how, with the Ordnance Survey map in hand, every journey, whether on foot or a-wheel, whether by road or rail, can to the intelligent and inquiring mind be full of interest.

The book opens with an account of the early maps of England, and deals with the work of Saxton, Norden, Ogilby, Cary, and others. The origins and early work of the Ordnance Survey are then described, and it is explained how much that service owes to Roy, Mudge, Colby, and James. An excellent description is given of the technical development of the national maps, from the early days of the black-and-white engraved sheets to the latest productions of the Popular and Relief Editions, with their wealth of colour and their admirable cartography.

Having dealt with the production of the form of the map, the author then gives the reader excellent instruction in how to use it, and further, how to benefit by all the information that it contains. There is a chapter on how to read a map, giving useful information and many practical hints. This is followed by a chapter on place-names. This is most valuable, and should arouse interest in this fascinating subject, and call attention to the excellent work being done by the English Place-Name Society. Then comes a chapter on archaeology, in which, combined with a good deal of information on the subject, it is shown how much can still be traced of the distant past. Successive chapters deal with historic times; with Roman Britain, the Saxon and Elizabethan periods, and with the seventeenth century. In all cases the author shows in the most vivid manner how, with the aid of the map, and particularly of the admirable "period" maps which have been published of recent years by the Ordnance Survey, a picture may be conjured up of the past, whether that past be comparatively recent or very remote.

The book is enlivened throughout by the most delightful touches of humour, of which perhaps the best is the remark that the hill-top forts in England are so impressive "that even those hurrying along the modern roads at 40 or 50 miles an hour have been known to express regret that they could not possibly afford time to stop and examine them." The illustrations include reproductions of ancient and recent maps, photographs of antiquities, and a striking example of an air-photograph. There is a short bibliography at the end of each chapter, and an index.

This is altogether a most engaging and informative book. Even those who have made a special study of maps will find much in it to interest them; while to the

general reader, for whom it is written, it should appeal greatly, and arose in him a better appreciation of the extraordinary amount of information that is contained in that priceless heritage of ours, the Ordnance Survey maps of Great Britain.

E. M. J.

THE CHILTERNS AND THE THAMES VALLEY (from Iffley to Staines). By S. E. WINBOLT. (Bell's Pocket Guides. English Counties.) *London: G. Bell & Sons* 1932. 7×4 *inches;* xxxii+282 *pages; illustrations and sketch-map* (*photographs by* E. WARD). 6*s*

This is the fifth of Bell's Pocket Guides and the first not confined to a special county. The scope of the volume has not been very satisfactorily arranged; the Thames valley is neither described in full nor limited to the Chiltern area, which in the other direction might well have been taken beyond Hitchin up to the Essex boundary. Although two of the author's six regions deal with the Thames valley, he adds a special account of a steamer trip, as he is struck by what he surprisingly calls the "comparatively modern neglect" of the river.

The information is tabulated as usual under the names of towns and villages, but not in alphabetical order. Mr. Winbolt is much happier with prehistoric earthworks or Roman remains than with mediaeval architecture. His description of St. Albans cathedral misses the three outstanding features, the immense length of the nave (a world's record), the brick tower, and the notorious "restorations" of Lord Grimthorpe; we are even asked to study the tracery of the monstrous rose-window, which was the most deplorable of his innovations. Mr. Ward's photographs maintain their usual level of excellence, particularly those of the Chiltern country itself, characteristic landscapes being very cleverly selected and treated.

J. H. R.

MY TOUR IN PORTUGAL. By HELEN CAMERON GORDON (Lady RUSSELL). *London: Methuen & Co.* 1932. 9×5½ *inches;* vii+288 *pages; illustrations and sketch-map.* 12*s* 6*d*

This book is composed of letters and extracts from journals written during a visit to Portugal. Evidently the author made a fairly long stay in or near Porto and she has written quite a good account. Her visits to other districts were short, so she has filled out the book with historical disquisitions which are rather distracting when one is trying to get an idea of the people and scenery. In visiting the vineyards of the Douro during the vintage she has noted more of the habits and life of the people. Unfortunately she was not there in the spring so does not give a description of the beauty of the mountains when covered with wild lavender, gum-cistus, and heaths. She has also failed to note that the treaders are not usually the natives of the district (of whom there are very few), but chiefly Spaniards who flock over the border in large numbers for this purpose. One has very little chance of visiting this district unless invited as a guest to one of the estates which are all privately owned by the various wine merchants.

The author's interests are chiefly architectural and historical. Though mentioning in some detail her arrival at Leixões and the journey to Porto she does not realize why the Portuguese made such an elaborate harbour at Leixões, which is some miles from Porto and not at Porto itself. The reason is, of course, that a formidable bar stretches across the mouth of the river and only comparatively small boats can get into Porto. She also scarcely mentions Foz do Douro, which is at the mouth of the river and is rapidly becoming a fashionable watering-place with a fine promenade and gardens. The blue-and-white tiles at Bussaco, by the way, are modern Portuguese, not Dutch, as stated.

The fisher folk, especially those of Povoa de Varzim, are more probably

northern immigrants than descendants of Phoenicians, as indeed one would conclude from their appearance, and in particular from their blue eyes. They have to a considerable extent kept themselves apart from the surrounding population, and form one of the finest types in the country.

The book is obviously not intended to be a comprehensive guide, but one would expect more mention of the scenery which is the real charm of Portugal. In this respect, her book hardly ranks with Martin Hume's 'Through Portugal.' H. M. C.

ASIA

IN NEW JAPAN. By AYLWIN BOWEN. *London: H. F. and G. Witherby* 1932. 9×5¼ *inches;* 304 *pages; illustrations and sketch-map* (by HAROLD E. WOODCOCK). *12s 6d*

This work consists mainly of descriptions of the author's journeys to and from Japan and of his travels in that country, and in part of accounts of, and his comments on, various events which took place there during the twelve years which followed the Armistice.

It is evident that Mr. Bowen is a competent observer of material things and can describe them clearly; and if therefore his method had been consistently objective he would have produced a better book than he has done. His work, as it stands, is marred by an obtrusive egotism, by inaccuracy, and by opinionated statements which do not indicate any careful examination of facts. "350,000 *yen*" (p. 151) is presumably intended for "350,000,000 *yen*," and "Prince Kunomiya" (p. 270) for "Prince Kuni"; the Government Iron Works at Yawata were not established, as the author states (p. 144), during the war but some fifteen years before its outbreak. Mr. Bowen would moreover do well, before writing another book, to study, in particular, pp. 36–48 of Messrs. Fowlers' "The King's English" (3rd edition): his use of italicized foreign words reminds us of the late William Le Queux at his worst. The expression "in *Taisho Ni*" (p. 275), for instance, is meaningless.

There is some sound work in the pen-and-pencil sketches by Mr. Harold Woodcock with which the book is illustrated; the frontispiece and the sketch facing p. 280 are particularly pleasing. E. H. DE B.

LA CARTOGRAFIA ANTICA DELL' INDIA. Parte III. Il Secolo delle Scoperte. By FRANCESCO L. PULLÉ. (Studi Italiani di Filologia Indo-Iranica. Vol. X.) *Firenze: G. Carnesecchi e Figli* 1932. 9½×6 *inches;* xxvi+182 *pages; facsimile maps, with separate "Atlante"* (*Studi Italiani* . . . Vol. IV, Tav. 5–12). *£1 2s 8d*

This is the third part of Signor F. L. Pullé's valuable studies in the history of the geographical knowledge of India. It deals with the period of the discoveries of the travellers of the thirteenth to fifteenth centuries and of the early Portuguese navigators, carrying the story down to the close of the sixteenth century, when, the author says, pre-eminence in cartographical knowledge and execution and, as a result, ascendancy in commerce, wealth, and colonial power passed from Italy to more northern countries. Attention has naturally been devoted chiefly to maps and records of Italian origin, and of these Signor Pullé gives a full and careful chronological survey. The method followed is to trace the evolution of the cartography of India and the Far East by studying the delineation of the countries by each cartographer with reference to his individual knowledge as well as the general knowledge existing in his time. A systematic investigation of this character reveals the paramount influence exerted by the Ptolemaic con-

ceptions of the configuration of southern and south-eastern Asia, reflected also in the early Arab and Catalan maps, persisting even for nearly two centuries after the Polos' travels had drawn the veil from those parts. As regards India, the most striking example of this lies in the failure of the earlier maps to give any idea of the outstanding feature of its contour, namely, the great peninsula. The Bianco-Leardo-Walsperger maps of the second quarter of the fifteenth century were perhaps the first to break with the old tradition by delineating the peninsula in more or less triangular form, and the Cantino-Canerio maps (1502–03) were the first to give a fairly correct representation thereof. But in the interval and for nearly half a century later (cf. S. Munster's map of 1550) reversion to the Ptolemaic ideas becomes noticeable. This is the more remarkable in view of the knowledge of India brought back by Nicolò de' Conti, who traversed the peninsula, penetrated the Gangetic basin deeply, and crossed the bay of Bengal from coast to coast in the first half of the fifteenth century (? 1415–39). The author emphasizes the importance of Polo's record towards a correct appreciation of Asiatic geography. Had his narrative been treated with less incredulity the effect would have been reflected in the maps of the fourteenth and fifteenth centuries; and we can only agree with Nordenskiöld that his descriptions did not exercise any real influence on cartography till they had been confirmed by the Portuguese voyages of discovery.

In one of the most interesting chapters in the present volume Sr. Pullé deals with the anonymous Genoese world map of 1447 and Fra Mauro's map of 1459, and compares the legends on these maps with the descriptions of Conti as recorded by Bracciolini. He suggests that Fra Mauro may have had the assistance of Conti himself in Venice. We think however that in the case of the 1447 map the likeness of phrase is more noticeable, so remarkable in fact in some instances as to lead to the inference that the drawer of the map either had Conti's record before him or had an opportunity of consulting the traveller personally. The Maragama of this map obviously represents Conti's Marahatia (the terminations which *gama* and *hatia* represent having a similar signification in the vernaculars), while Arnona is clearly intended for Conti's Cernove (*ce* becoming *a* by an obvious clerical error). Perhaps even more interesting is the position assigned on this map to the mountains in which "carbuncles" were to be found, in relation to the "river of Ava," the river on which Maragama stood, and the "region of Catayu." We consider, in fact, that this map affords evidence that Conti went up the Meghna and Brahmaputra, and not up the Ganges, as most cartographers seem to have been led to suppose. We notice that Sr. Pullé is inclined (like Yule and M. Longhena) to equate Conti's Buffetania, al. Pudefetania, with a port on the Malabar coast, but Kunstmann had reason for suspecting that some port in or near the Kistna delta was intended; otherwise it is not easy to account for the mention of the two cities, Odeschiria and Cenderghiria, which can only refer to Udayagiri and Chandragiri in the Nellore and North Arcot districts respectively, which lie comparatively near to the east coast, and both of which were important places at the period. There can be no question of sites in the Puri district of Orissa, as Sr. Pullé seems to think possible. Khandagiri and Udayagiri in the latter district were never towns, nor could Conti have gone anywhere near that locality in a twenty-days' trip between Penukonda (undoubtedly Conti's Pelagonga) and the coast. Fra Mauro has misplaced all these sites on his map, just as he has reversed the relative positions of other sites.

In connection with the references to "the Indian pilot called Guzarate" (p. 78), "the pilot Malem Cana" (p. 80), and Sidi Ali's *Mohît* (pp. 82 f.), attention may be drawn to G. Ferrand's 'Introduction à l'astronomie nautique arabe' (pp. 183 f.), where the identity of da Gama's pilot and the sources of the *Mohît*

have been dealt with. We are not aware that Masulipatam was ever known as Maliarpha (p. 84): Ptolemy's mart of this name lay to the south of the Kistna delta, as McCrindle has explained. Kâlib i Rûmî (pp. 82, 83 n.) should read Kâtib i Rûmî; and Caro (p. 92) is apparently a mistake for Gâro. We do not think there is any valid reason for thinking that the division of India by the old geographers into intra- and extra-Gangem might have been based upon ethnographic, rather than geographic considerations (p. 90): the Ganges has not acted as a racial boundary. C. E. A. W. O.

AFRICA

REPORT ON BORING FOR OIL IN EGYPT. By T. SUTTON BOWMAN. Section I. Government Petroleum Research Operations (1925), xii+68 *pages*. Section II. Sinai (1926), xvi+92 *pages*. Section III. Eastern Desert and adjoining islands (with index to Sections I, II, and III) (1931), xvi+354 *pages*. *Cairo: Ministry of Finance, Egypt* (*Mines and Quarries Department*) 1925–31. 11×7 *inches; maps.* P.T. 10, 10, *and* 30

Geographers may find indigestible the fare which Dr. Bowman provides in this book, but as a compendium of facts relating to the prospecting for and winning of oil in Eastern Egypt and the neighbouring islands it is adequate. In the first three chapters he deals with Jebel Zeit, Ras Gemsah, Dishet el Da'aba, Juftun Kebir, and Abu Sha'ar, as well as introducing his subject. There follows a long chapter upon the exploitation of Hurghada, Egypt's only important oil-field, and its discovery in 1913. In this field the oil is drawn from sands and shales of Cretaceous age. The abortive operations on Jubal, South Gaysum, and Ranin Islands, and in the Ras el Bahar, south-east and south-west Zeitia, Ras Dih, and Ras Gharib areas are next discussed together with the nearly exhausted oil-field of Gemsah. It seems to be as difficult to determine the origin of the oil at Hurghada as it is in most other oil-fields. The volume ends with an index of seventy-seven pages, in which is listed the matter of this book and two companion sections which together make the complete report.

The main scientific interest lies in the careful micropetrographical work which Dr. Bowman has done on the sediments of Eastern Egypt. His researches show that the concentration of heavy minerals such as tourmaline, rutile, zircon, sphene, epidote, etc., is a reliable stratigraphical marker over a limited area in the Kainozoic sediments. The presence and significance of foraminifera and diatoms are pointed out. But let the author be of a stout heart, for if he be no diatomist (p. viii) he is a stalwart petrographer, and has written a 'Domesday Book' for the oil operations in Eastern Egypt. J. V. H

CENTRAL AND SOUTH AMERICA

A NATURALIST IN THE GUIANA FOREST. By Major R. W. G. HINGSTON. *London: Edward Arnold & Co.* 1932. 9×5½ *inches;* xiv+384 *pages; illustrations and sketch-map.* 18*s*

Many a naturalist must have gazed longingly upwards from the gloom of a forest floor and wished he could penetrate the thick canopy which he knows to be teeming with animal life. The Oxford Expedition to Guiana achieved this dream by means of pulleys and platforms, and Major Hingston describes what they saw. In addition the book contains an account of the author's observations chiefly of the devices evolved by insects and spiders to conceal themselves for purposes of protection and aggression. There are spiders which draw attention away from themselves by patterns or lumps of debris moulded in rough conformity with their own shape and size; insects which cover their bodies with debris; and others which curl their tails to hoodwink their enemies into thinking

they possess stings. Wasps and ants are serious enemies of spiders, but in one case the roles are reversed and a spider carries a dead ant as a kind of passport under cover of which it can attack others.

Much of the expedition's material has not been worked out yet, and to some extent the book suffers in consequence. In the absence of a spider systematist Major Hingston has named twenty-seven species, but his descriptions are inadequate. The author is inconsistent in his use of the synonyms *Theridion* and *Theridium* (p. 221); *Uroctea* should read *Oecobius* (p. 199), *Misumeta Misumena* (p. 203), *Thomisus omistus Thomisus onustus*, whilst *Tetragnatha extensa* cannot be described accurately as bright green (p. 205). These are small slips in a book that is full of interest to the biologist. W. S. B.

PEOPLE IN THE SOUTH. By ALAN PRYCE-JONES. *London: Cobden-Sanderson* 1932. 9×5½ *inches;* 264 *pages.* 8*s* 6*d*

Since Mr. Pryce-Jones has disdained the usual travel-book formulae, and has allowed the South American landscapes to "people themselves in his mind" and so to exhale their peculiar aroma through a purely fictional medium, his book, if it is to creep into the geographical fold at all, must rank as an extreme instance of Human Geography. Once admitted however it cannot fail to please and interest those whose minds are sufficiently alert to follow the author's rapid and allusive style, a style far more successful here than in his first book. Indeed, it is surprising to find Mr. J. C. Squire sending the reader back from the swift and accurate certainty of 'People in the South' to the rather tiresome undergraduate humours and obscurities of 'The Spring Journey.'

The bright colours and hard sunlight of Latin America are vividly presented in the Ronald Firbank manner. The bulk of the book consists of three short stories designed to display the characteristic qualities of Chile, Ecuador, and Brazil; but the short introduction gives a highly stimulating vision of the continent as a whole. Who, whether he knows Chile or not, can fail to respond delightedly to so fresh a picture as this: "In Chile what is not Tyrolean is dead. The southern lakes provide their own castles out of the rocks above a green, chilly fruit-and-sheep country copied and enlarged from photographs of the Salzkammergut." D. C. S.-T.

AUSTRALASIA AND PACIFIC

HANDBUCH DER KLIMATOLOGIE. Edited by W. KÖPPEN and R. GEIGER. Band IV. Teil S. Australien und Neuseeland. I. Climatology of Australia; by GRIFFITH TAYLOR. II. Climatology of New Zealand; by E. KIDSON. *Berlin: Borntraeger* 1932. 10½×7 *inches;* vi+138 *pages; maps. M.*20 (*subscription price*)

Students of climatology will welcome this section of the handbook edited by Köppen and Geiger, even though the material is available elsewhere to a large extent. The greater part of the volume is occupied by a very comprehensive account of the climatology of Australia by Professor T. Griffith Taylor, whose publications on the subject are already well known. It is divided into four parts, of which the most readable is Part I, General Climatology of Australia, wherein his neat graphic methods of correlation, as originated in his book 'The Australian Environment,' are used to great advantage. In such a small compass the generalizations are of necessity somewhat sweeping, and the complications of the subject either suppressed or greatly modified. Part II, the Regional Climatology of Australia, is almost a geographical study, in that the author is constantly referring to the incidence of climate on the occupations of man. Part III is a short chapter on the correlation between climate and vegetation by W. Köppen, and is written in German. Part IV consists of tables supplied by the Commonwealth Meteoro-

logical Service, in which the headings and explanations are sometimes in German, sometimes in English.

Dr. E. Kidson is responsible for the last section of the book, the Climatology of New Zealand. This section is perhaps somewhat more professionally climatological, but in a short span gives a very clear account of the characteristics of the New Zealand climate and its proximate causes. The tables which follow are all in English, and, compressed into nine pages only, seem to be a good selection from the large mass of data which must be available. F. D.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

THE UNSTABLE EARTH: some recent views in geomorphology. By J. A. STEERS. (Methuen's Geological Series. General Editor J. W. GREGORY.) *London: Methuen & Co.* 1932. $7\frac{1}{2} \times 5$ *inches;* xiv+342 *pages; diagrams and maps.* 15*s*

Complaints have been made of late that geological discussions are now carried on in a language strange to those who were students less than a generation ago. What, they ask, are "sial" and "sima"? This book is written to answer such questions and explain the many controversial subjects that have arisen within the science of geology. It falls into two parts: Chapters I–IV deal with the broadest facts of Earth-structure and the more or less conflicting theories that attempt to explain them; while Chapters V–VII are concerned with the special problems (raised beaches, coral-reefs, etc.) connected with changes of sea-level.

The inquirer who starts by sampling the work and seeks for the meaning of "sial," will be disappointed; for, through an imperfection in the index, the first reference to that term (p. 58) is omitted. With "sima" he will have better luck, and find that both terms have a very simple derivation. There are some other imperfections in the index: "Kratogenic" is missing, and though "lambeau de poussée" is there, the only reference given does not explain the term. There is need of a glossary.

Sampling having given these results, we proceed to the more difficult task of steady reading. The task before the author was a heavy one: he had to present incongruous theories with impartiality, or assess their merits according to the evidence, not to the attractiveness of the terminology; to discriminate between proved facts and inferences expressed in terms of an unproved theory, between generalizations free and not free from theoretical bias. We do not feel that he has achieved complete success, though it may be that no one else could have done better. We doubt if he has chosen in all cases the best order of presentation, and his style is not always clear, reaching maximum obscurity in the phrase: "one can hardly deny that geological thought is entirely unfavourable to some form of drift" (p. 159)—practically a triple negative, though the use of "some" in place of "any" suggests that perhaps only a double negative was intended.

These criticisms made, we must recognize that the book does contain a very full account of the bigger problems of modern geology, and any one who is prepared for some very stiff reading may expect to learn how wide a choice of theories await his judgment. It is impracticable within the limits of a review to give even a list of the very many subjects dealt with. The last part of the book, dealing with a subject of which the author has special practical experience, is certainly the best. A. M. D.

ECONOMIC AND HISTORICAL GEOGRAPHY

RUSSIA: A SOCIAL HISTORY. By D. S. MIRSKY. *London: The Cresset Press* 1931. 10×6 *inches;* xx+312+xxi *pages; illustrations and maps.* 25*s*

This is the first of the Cresset Historical Series, which is intended by the editor,

Professor C. G. Seligman, F.R.S., to "cater directly for the man whose interest in any given country or area is primarily cultural" and not to provide a mere chronicle of events. It is therefore not without interest for the geographer, and very sensibly starts with a chapter on the geographical background. This is mainly the great Eurasian plain, in which the Urals form an insignificant longitudinal barrier and the climatic and vegetational belts divide the human groups latitudinally into hunters, agriculturists, and pastoralists. "In terms of human geography the recent history of Russia may largely be described as the advance of the agricultural wedge against both hunters and nomads." The importance of the great rivers to the agricultural and forest belts is brought out, while the arid steppe to the south is shown to be practically riverless from the River Ural to the Great Wall. The essential unity of the Russian plain and the difference of climate east (continental) and west (Atlantic) of the 30th meridian leads the author to speak of Europe as excluding Russia, which is cut off from the unifying and westernizing influences both of the Mediterranean and, except for the innermost bay of the Gulf of Finland, of the Baltic. The Carpathians he calls entirely European and un-Russian in their physiography; between them and the Baltic Russia has "immediate access only to the very backwoods of Europe."

While the book deals primarily with the Great Russians or Muscovites, the history of other peoples is naturally involved, and foremost among these are the Ukrainians and White Russians who sometimes have a separate column in the chronological table at the end. There is also a synoptic table of Peoples of the U.S.S.R. on the lines of the Russian Academy's "List of Nationalities" noticed in *G.J.*, vol. 73, pp. 370–4. The use of the Russian word Kazak often leads to confusion, as it has widely different meanings; therefore three spellings have been employed here: the conventional English Cossack, applied to autonomous military communities in Muscovite Russia; Kozak, the Ukrainian form of the word, used of the dominant section in the Ukraine, especially in the seventeenth century; and Qazaq, the Turki original, confined to the Turkic people of Qazaqstan (Russian Turkistan).

The plates illustrate national art, chiefly architecture. The sketch-maps are clear and useful, one showing that "south-west" and "south-east" on p. 22 should be transposed. J. H. R.

THE GREAT AGE OF DISCOVERY. Edited by A. P. NEWTON. *London: University Press* 1932. 9×6 *inches;* xii+226 *pages; illustrations and facsimile maps.* 15*s*

The work of the great explorers is now well established save for minor details, so that a work dealing with their epoch, if it is to break new ground, must place their achievements in relation to contemporary life, and take account of the scientific ideas which prompted and controlled their actions. It is by the extent to which it realizes this purpose that this book must primarily be judged.

Each chapter was in origin a lecture by a specialist delivered at King's College, to which bibliographical references have been added to assist further study. There is also an excellent series of illustrations—portraits, as far as possible contemporary, works of art, and portions of maps.

The first chapter, by Dr. Antonio Pastor, gives an eloquent and enthusiastic, if sometimes partial, account of contemporary Spanish civilization. He distinguishes three characteristics of the typical Spaniard—"an elegant melancholia," a "knightly courtesy" seeking to create another and fantastic world, and, in seeming contradiction, a belief in the destiny of the human race to fulfil itself in the external world. These characteristics certainly explain many of the actions of the Spaniards, but perhaps rather as "conquistadores" than as scientific explorers. It is noticeable that there is much in this chapter about the rise of

humanism, but little of actual scientific progress in Spain. The crusading spirit is also emphasized, and there is a somewhat baffling reference to the "magnificent humanitarian Spanish legislation" for the Indians, "ignored by many English historians." No references are given to assist in following up this line, which seems to be promising—especially after the qualification of Las Casas's policy as "impracticable."

The editor then takes up the controversial subject of Columbus and his aims. He demolishes much of the conventional version of his life, but allows that, under the influence of Marco Polo, he was probably seeking Cipangu as well as unknown islands in the west. The tendency is also displayed to depreciate Columbus's scientific knowledge, but there is more to be said for it than appears here. The share of the Italians is also minimized, but such an attitude does little to raise the credit of the Spaniards. If Columbus had so little to offer the Spanish sovereigns, it is difficult to understand how the initiative was left to him. There are passing references throughout to Pinzon's share in the discovery, but there is hardly sufficient evidence to make him a competitor for fame with Columbus.

The dissemination of the news of the discovery receives adequate notice, and the services of Peter Martyr in this direction are deservedly emphasized. It is shown that, whatever Columbus's aim may have been, his contemporaries saw no difficulty in accepting his statement that he had reached the Indies. The other chapters, more nearly narrative in form, include Vasco da Gama and the way to the Indies by Professor Edgar Prestage, and the first explorers of the North American coast by Dr. H. P. Biggar. The final chapter by Professor E. G. R. Taylor traces lucidly the effect of what seems likely to have been authentic knowledge of Greenland and the northern waters in the fourteenth century, through a systematized version in the lost 'Inventio Fortunatae' attributed to Nicholas of Lynn, upon the English seekers after the Northern Passages in the sixteenth century. As was almost universally the case in this epoch, the preliminary theorizing was at fault, but it served its purpose in inciting explorers to reveal the true configuration of the globe. G. R. C.

SIMON VAN DER STEL'S JOURNAL OF HIS EXPEDITION TO Namaqualand, 1685–1686. Edited by G. WATERHOUSE. *Dublin: University Press* 1932. 11 × 7 *inches;* xxviii + 184 + [38] *pages; illustrations and sketch-map.* 25*s*

When examining the Fagel collection in the Library of Trinity College, Dublin, Professor Waterhouse discovered the MS. here printed, of which the significance had not previously been realized. He shows that it is probably the official account of van der Stel's journey in Namaqualand, which has been missing from the Archives in Holland of the Dutch East India Company since the end of the eighteenth century. The journey had previously been known from François Valentijn's text published in his 'Beschryvinge van de Kaap de Goede Hoop,' 1724. The editor, in an article in the *Geographical Journal* for October 1924, had already dealt with the variations between these two texts, and reproduced some of the illustrations.

This volume contains the Dutch text, an English translation, and reproductions of all the drawings—mainly of the fauna and flora—with identifications. These were the work of the artist Hendrik Claudius. The text contains information about the Hottentot tribes encountered; the party came into conflict with the natives on one occasion, but the incident is suppressed in this account. The object of the expedition was to explore and examine the "Copper Mountains," about 300 miles north of the Cape. A certain amount of blasting and smelting was done, and specimens were brought away, but the later history of the mines is not recorded here. This is of course the mining area now served by the Port Nolloth Railway.

The author acknowledges handsomely in his prefatory remarks assistance received in his researches from members of the Society's staff. G. R. C.

GENERAL

A HANDBOOK FOR GEOGRAPHY TEACHERS. Edited by D. M. Forsaith. *London: Methuen & Co.* 1932. 7½×5 *inches;* xii+336 *pages; illustrations.* 4*s*

The progress of geography teaching in this country might be illustrated by a comparison of three books of similar aim: 'Hints to Teachers and Students on the Choice of Geographical Books and Apparatus,' by Dr. H. R. Mill, published in 1897; 'Guide to Geographical Books and Apparatus,' by Professor Herbertson, Miss MacMunn, and the present reviewer, published in 1910; and, now, this book edited and partly written by Miss Forsaith, with the assistance of a large number of teachers in various grades of schools and colleges. It might be noted how in these books the proportion contributed by those who have had experience in teaching children has increased, and similarly the references to books written by teachers as distinct from geographers or those professing allied subjects have multiplied; moreover the bulk of the volumes has considerably expanded as their scope has widened.

To illustrate this point and to show the value of the present book, one cannot do better than to survey its content. The first chapter gives wise advice on the construction of syllabuses, with specimen schemes for infant, junior, senior, rural and central schools respectively. (In parenthesis it may be said that though the book is intended primarily for teachers of children up to the age of fourteen years, there is much in it useful to those instructing older pupils and students.) The second chapter is devoted to "Indoor Geography" and its equipment, with a photograph and plan of a "geography room," and very full, annotated lists of articles on the subject, globes, wall-maps, ordnance and geological hand-maps, outline maps, duplicators, pictures, posters, lantern slides, episcopes, cinema films, and broadcast talks; one wonders what teacher could say he is familiar with all the practical information in this chapter alone. The following and complementary chapter deals similarly with outdoor geography in the playground, regional survey, and school journeys.

The chapter which occupies the greater part of the volume is headed "Book Lists"; the title is an understatement, for there are comments on all the books mentioned, and besides those written for teachers and scholars respectively, there are lists of *biblia abiblia* in which category one must include statistical returns of all kinds, and might include many of the Government publications of various countries, which afford useful raw material to the teacher of geography. Equally off the track of the ordinary geography text-books, but branching in very different directions, are sections on Guide Books, and on "Geography in Literature," in which the first entries consist of chapter-and-verse references to the descriptions of habitations and crafts described in the Bible, and the last entries deal with the South Sea Islands, concluding with Stevenson's 'In the South Seas,' and Tennyson's 'Enoch Arden.' How geography may contribute to education in the widest sense of the word is indicated by sections on "Handwork," "Pastimes—dances, games, plays, songs, etc.," and "Books for Retarded Children."

Very different, but equally useful, and quite up to date from the points of view both of method and of the material incorporated, are the last two chapters, on "The Teaching of International Geography" and "Geography and the League of Nations," contributed by Mr. G. J. Cons. J. F. U.

THE MONTHLY RECORD

INTERESTING ADDITIONS TO THE MAP COLLECTION

The Society has recently purchased a copy of an interesting old hydrographic atlas, with the following title: "A New Directory for the East Indies, containing general and particular charts for the navigation of those seas, wherein the French Neptune Oriental has been chiefly considered and examined. With additions, corrections, and explanatory notes. By William Herbert, Hydrographer. The second edition with the supplementary charts. London: Printed for the Editor at the Golden-Globe, under the Piazzas, London-Bridge, 1758." The atlas measures 25 by 19 inches and contains thirty charts of the coast of Africa, the Indian Ocean, and the East Indies, including four unnumbered supplementary charts, one of which bears the date 1759. An account of the life and work of the author is given in the Dictionary of National Biography.

Another recent acquisition is "A Chart of the Coast of Guyana, Comprehending the Colonies of Berbice, Dunerary and Essequibo, by Capt^{n} Tho^{s} Walker, Ass^{t} Q^{r} Mast^{r} Gen^{l} 1st October 1798." This is a detailed coloured chart, on the scale of 1 inch to 3 miles, and shows the courses of the rivers for about 80 or 90 miles from their mouths, with the estates and proprietors' names along the banks. There is also an enlarged inset plan of the "Mouth of the River of Demerary and its Environs." This chart is especially interesting since its date is only two years after the two colonies of Demerara–Essequibo and Berbice became British territory. It measures about 5 by 4¼ feet, and was published, 1 December 1799, for the proprietor, by C. G. Playter of Lewisham, Kent, and R. Wilkinson of 58, Cornhill.

SIR CHARLES CLOSE'S NEW BOOK

Fellows of this Society, and indeed the people of this country, are indebted to Sir Charles Close for much work of a geographical nature. He has increased this debt by the publication at a very small price of a delightful book, a full review of which from an expert hand appears elsewhere in this issue. It is characteristic of his mind and character—simple, lucid, and full of information devoid of jargon. The chapters on old maps are an incentive to all to examine them. The origin and history of the Ordnance Survey is a matter of great interest. Let no accomplished and well-informed person be warned off Chapter IV, for he or she will find in it many things of which they may have been ignorant. How many people, for instance, know that the cross-pieces on the telegraph poles are always on the side nearest to London? The chapter on place-names is full of information, both as to prefix, suffix, and composition. The concluding question to the varied spellings of Wychwood is admirable. The chapters on Saxon, Elizabethan, and Seventeenth-Century England are a fine blend of mapping and military history; and at the end Bunyan himself will have been happy to have been so selected.

RAINFALL OF SENEGAL

Professor R. Rousseau, of the Lycée Faidherbe, Saint-Louis, Senegal, describes some new annual and monthly rainfall maps based on thirty-two stations fairly well distributed over the colony of Senegal. The maps and text under the title "Les Pluies au Sénégal de 1887 à 1927," appear in the *Bulletin du Comité d'Études Historiques et Scientifiques de l'Afrique Occidentale Française*, tome XIV, nos. 1–2, 1931. The distribution of rainfall over the colony exhibits a marked latitude or solar control, the average annual amount ranging from 1500 mm. or 60 inches in the south to only 300 mm. or 12 inches in the north.

In the dry northern portion of Senegal however the distribution is much more irregular and disturbed by local factors. Cold water north of Cape Verde keeps the northern part of the coast arid, but at Dakar just south of the Cape the conditions are already much more humid.

The seasonal distribution of the rainfall is sharply defined, and appears to be related quite simply to the two passages of the vertical sun which in this region between lat. 12° and 16° N., occur about May and August. The rainy season, known as the "hivernage," embraces the five months June to October. In the extreme south the rains start in May, gradually working northwards and becoming fully developed by July, for which month the isohyets show a distribution over the country similar to those of the annual map. But owing to the development of a coastal monsoon with accompanying tornadoes, disturbing the simple solar control, the wettest month is August. In September the rainfall resembles that of July, and in October that of June, while in November and December a minor rainy season called the "petit hivernage" is ascribed to a belated effect of the second passage of the vertical sun. The variability of the rainfall from one year to another is much greater in the dry northern districts than in the south, where the rains are abundant and less affected by local influences. It may be pointed out that a table showing the dates of the two passages of the vertical sun over the various stations is partly incorrect, making the features of the seasonal distribution of the rainfall difficult to follow until the error is discovered.

NORWEGIAN TRAVERSE OF THE GREENLAND ICE-CAP

One of the most successful expeditions carried out in Greenland within the past few years is that of the two Norwegian scientists, Arne Høygaard and Martin Mehren, who, in the summer of 1931, crossed from west to east over the whole breadth of the inland ice-cap. A summary account of their experiences and the results attained has appeared (in Norwegian) in the *Norsk Geografisk Tidsskrift*, 1–3 Hefte 1932. The outward voyage was made in the *Sussaa*, the same vessel which took out Dr. Kurt Wegener to the base-station of the German expedition, after the lamented death of its leader, Alfred Wegener. This had been chosen by the Norwegians as their starting-point owing to the comparatively easy ascent to the ice-cap afforded by the Kamarujuk glacier, and the first part of their route coincided with that of the Germans. The main field of new exploration therefore lay on the eastern side, where the work of the Cambridge expedition under Wordie in 1929 had revealed an extensive mountainous region stretching north and west of Petermann Peak. The route was so chosen as to pass through or near this region before debouching on Franz Josef Fjord on the east coast, and thus to throw further light on its extent and nature. Arrangements were made that in case of success the explorers should be picked up either by Hoel's ship, the *Polarbjørn*, timed to sail from the fjord on August 20, or by Lauge Koch's, the *Godthaab*, due to leave on September 1. This would allow about fifty days for the crossing, entailing an average daily stage of 20 km. to complete the 1000 km. of the route. This average was in fact considerably exceeded, the journal frequently recording marches of 30 km., and, on one day at least, of 40 km. The ascent to the ice-cap was made with the help of the Greenlanders at the German station, and the further route, begun on July 10, after following that of the Germans some 70 km., struck north-east into the unknown. On July 15 the altitude for the first time exceeded 2000 m., continuing gradually to increase until on July 30 it reached 3020 m., with a further slight rise on August 1 to a maximum of 3040 m. It then fell regularly till the border of the mountains was sighted, through fog, on the sixth. The ice-surface, broken by a succession of *nunataks*, was here about 2500–2600 metres. To find a passage through the

mountains it was necessary to bend somewhat northwards, a large glacier—named after Adolf Hoel—being then found and followed down to the Waltershausen glacier, which enters the North Fjord arm of Franz Josef Fjord. The worst part of the descent was at the junction with Waltershausen glacier, a feasible route being found with some difficulty. The journey ended on August 18, just in time for the explorers to be taken on board the *Polarbjørn*.

During the whole route daily observations of temperature, wind, and terrestrial magnetism were taken, and are now being worked out. They confirm the existence of a great anticyclonal system over Greenland (though this is naturally modified by special factors near the coasts), and some help in propelling the sledge was gained in the latter part of the route from the prevalent winds from the west-north-west. Considerable interest attaches to the geological specimens brought back, particularly those obtained from the *nunataks* west of the mountains, the most remote site in the interior of this part of Greenland from which such have been obtained. They appear to belong to the Petermann series of Wordie, thought by him to be sedimentary rocks of pre-Cambrian age (cf. *Geological Magazine*, 1930, p. 151). If so, this series must reappear to the *west* of the older metamorphic belt by which the strata observed by Wordie appear to be underlain to the west of Petermann peak.

This crossing of the ice-cap is the first effected at its full width since J. P. Koch's of 1913 (see *Journal*, vol. 42, p. 548), with which it was roughly parallel, some 150 miles farther south. The maximum altitude reached seems the greatest yet recorded, Koch having nowhere quite attained 3000 metres, while the greatest elevations have been generally thought to lie rather north than south of his route. The greatest elevation found by the British Arctic Air Route Expedition much farther south (in 63° N. Lat.) was about 2800 metres (9200 feet).

SALT DOMES

Although the features known by this name have been known and discussed for many years it is only within the past thirty that enough accurate observations have been made to throw any clear light on their age, structure, and mode of origin, on which complete agreement has not even now been reached among geologists. They are of interest to the geographer not only as remarkable surface-features, but also from an economic standpoint, from the association with them of supplies of oil capable of exploitation. In view of the somewhat puzzling problems involved, a symposium on the subject was last year arranged by the Institution of Petroleum Technologists, and a report of the proceedings reprinted from the *Journal* of the Institution has been kindly sent us by Dr. A. Wade, who contributed one of the set papers and also took part in the discussion which followed.

The phenomenon has now been observed in various widely separated regions, the most important being the plain of North Germany, the coast region of the Gulf of Mexico, Romania, and various parts of south-west Asia, particularly the Gulf region of Southern Persia and Asir in South-Western Arabia. In the majority of cases, as was pointed out by Dr. Wade, they occur on the margins of tectonic depressions—coastal belts corresponding to major zones of fracture of the Earth's crust. Almost everywhere they present closely similar characters and would seem to have a generally similar origin. The salt is usually found in columnar or conical masses, more or less circular in horizontal section, and has been pushed up through other strata, sometimes of great thickness, presenting marked analogies with the plugs of volcanoes or other igneous intrusions. If the superincumbent strata have been broken through completely, dome-shaped hills of salt may result, with a girdle of other sediments, down the slopes of which

the salt may sometimes overflow after the manner of glaciers. Otherwise the domes may be "closed," consisting of other sediments raised above the tops of the salt masses beneath. A common feature in the former case is the formation of a cap of calcite, gypsum, and anhydrite, the mode of formation of which is still somewhat obscure.

Most of the older theories as to the origin of the domes must now be discarded, and although the speakers at the recent discussion were not entirely agreed on points of detail, there was a general consensus of opinion (1) that the domes are derived from normal sedimentary saline deposits, which may be of any age; (2) that they are due to the flow of salt underground as a result of pressure, mainly from the weight of over-burden, but partly also from tangential pressure, which would be responsible for the orientation and initiation of the domes (it was pointed out that the plasticity of the salt under pressure would be greatly increased by the presence of moisture); (3) that there is no genetic connection between the oil-occurrences (as *e.g.* in the coast region of Texas, where they were first brought to light) and the salt, but that the association is as a rule merely a structural one, the domes affording suitable sites for oil concentration. The generally circular form and isolation of the individual domes seems to be somewhat difficult of explanation, for it might have been expected that their arrangement would be more or less linear, as in fact it is in Romania. The probability is that the swelling salt made use of points of local weakness, such as the intersection of joints or fault-planes. It was also pointed out that the circular section would be that of least frictional resistance, though one writer expressed doubts whether the assumption of cylindrical form was always justified by positive data.

PHYSIOGRAPHY OF THE LONDON BASIN

The paper which Dr. S. W. Wooldridge read to the British Association last year upon the physiographic evolution of the London Basin is printed in *Geography* for June 1932. After tracing the development of the structural features from early Tertiary times, he suggests a division into regions based largely but not entirely upon geological and physical considerations, and with reference to agriculture and population.

The striking characteristic is the constancy or frequency of features of form throughout the period. There is evidence of a pre-Tertiary synclinal basin, drained by an ancestral Thames. The beginning of the present structure is the uplift which excluded the early Tertiary sea: this uplift was broadly contemporary with the Alpine building. The complex structure is a "rectangular network of minor folds and faults" running with the strike of the country, crossed by broader, more widely spaced folds—there is also a series of gentle north–south monoclines. This episode was succeeded by a long interval of erosion culminating in a peneplain, since uplifted. The advance of late Tertiary (Pliocene) sea which followed has left its traces in old coast-lines on the Chilterns and North Downs. The Pliocene marine platform was then raised by stages to its present elevation of 500–600 feet, producing a "series of maturely dissected plateaux" or "gigantic physiographic stairway" from the Thames terraces to the chalk downs.

Views on the pre-glacial drainage are then summarized, and the extent and character of the ice advance indicated. With the resumption of normal drainage conditions there followed the formation of the Boyn Hill and Taplow terraces, and finally the narrow flood-plain terrace. In early historical times the estuary was in a submergent state, the high-water sea channels being represented by the present marsh and alluvial areas.

The system of minor regions suggested by Dr. Wooldridge are, approximately, divisions of east–west strips, conditioned by the structure. The chalk plateaux

of the Chilterns and North Downs are covered with heavy clay-with-flints, bearing a "dry-oak wood" association. South of the Thames, the Tertiary outcrop is a definite regional boundary, extending as far east as Farningham. This, with the eastern extension of the Thanet sands, is classified as the "Kent Lower Tertiary Zone," and was an area of early agricultural development. The Bagshot and Blackheath sand and gravel plateaux carry an "oak-birch-heath" vegetation. North of the river, the historically important feature is the "London gravel ledge," the 50-foot terrace to which London was confined until well into the nineteenth century; west of this ledge, at a slightly lower level, is the gravel loam-covered plain of Southern Middlesex. To the north lies the strip of London clay country, divided by the River Lea into the clay plains of Middlesex and East Essex. This was the forest area of early times, through which the Lea valley formed an important breach.

The plateau of South Hertfordshire is formed of dissevered remnants of the gravel-covered 400-foot platform. It, too, is continued east of the Lea as the South Essex Uplands. On the north-west lies the important "Vale of St. Albans," a drift tongue between the Tertiary edge and the Chiltern plateau. The suitability of this region for settlement is attested by the early importance of Verulamium. Finally there is the Essex boulder-clay area, the historical history of which Dr. Wooldridge and Mr. Smetham dealt with in the *Geographical Journal* for September 1931. The interaction of these areas, with their differing potentialities, throws much light upon settlements and routes in historic times, *e.g.* the convergence of the agricultural areas of the Essex boulder-clay area and the Kent lower Tertiary belt upon London, and the relation of the latter site to the Lea valley and to Verulamium.

FURTHER ADDITIONS TO GEOGRAPHICAL LITERATURE IN GERMANY

In that well-known German series, *Forschungen zur Deutschen Landes- und Volkskunde*, several monographs have appeared lately. The following brief notes will serve to bring them to the attention of students, and to indicate their scope. 'Das Siegerland: ein Industriegebiet im Rheinischen Schiefergebirge' (vol. 28, i), by Dr. Theodor Kraus, is a detailed study, based upon observation and inquiry extending over several years, of an industrial area, said to be one of the most individual in Germany. It forms the upper basin of the Sieg, a right-bank tributary of the Rhine, and is deeply scored by small river valleys within the encircling highlands. Its social and economic history has been moulded by two facts—its unfavourable position in a mountainous interior and its wealth of mineral deposits. Dr. Kraus traces the history of the mining industry, established early in the fourteenth century (the "Stahlberg" mine near Müsen was started in 1313), and shows how the iron-ore industry is still carrying on despite the competition of more favoured areas, the older subsidiary industries having been destroyed by the introduction of modern methods elsewhere. There are a large number of sketch-maps and some excellent photographs.

Part iv of this volume is "Die Kulturlandschaft des hannöverschen Wendlands," by Dr. Anneliese Krenzlin. This area of north-eastern Hanover presents much of interest to the student of the historical distribution and forms of settlement. The eastern portion is lowland, originally forested, while the western is open heath on the higher diluvial plateau, similar to the Luneburger heath. It is also near the old boundary between Germans and Slavs. Dr. Krenzlin, by the aid of archives and existing surveys, studies the development of the present "cultural landscape." An interesting feature is the "round" village, or *Rundling*, to which a Slav origin is assigned. The economic development of the region was

at its highest during the late Middle Ages. The Thirty Years' War was but a temporary set-back; the present decline in population dates from about the middle of last century, following on the enclosing of the holdings.

Of the two parts issued in vol. 29, the first deals with a purely geomorphological problem. "Blockmeere" agglomerations of boulders, often covering a large area, of which stone rivers are a special form, are common in many parts of the world; Dr. Carl Schott's attention was drawn to them while in Spitsbergen, and he continued the study in the German Mittelgebirge, his results being published in this fascicule. He shows the forces, mechanical and chemical, which produce these boulders, the meteorological and structural conditions most favourable to their formation, and the transporting agencies. The basic cause is erosion, but their distribution is not solely determined by climate. They are more prominent in areas of sparse vegetation. The other part, by Dr. Hermann Gsteu, deals with the human geography of the Vorarlberg upon lines common to studies of this type. The distribution and density of population is given in great detail, and the historical development traced. It may be noted that the population, 140,000 in 1923, has now almost regained the figure for 1910, the highest recorded. Much attention is also paid to the forms of the settlements, to domestic architecture, and to the dress of the people.

THE NAME OF PORTO RICO

We are informed by the Foreign Office that in May last an Act was passed by the United States Congress changing the name of the island of "Porto Rico" to "Puerto Rico," thereby confirming an Act which had been passed by the local legislature to effect this change in the spelling. "Puerto Rico" is the proper Spanish name of the island and was officially used down to its cession to the United States in 1898. But, as Longman's *Gazetteer* of 1895 remarks, it was frequently called in English and French "Porto Rico"; and this was the spelling adopted by the United States and was that laid down in the Fifth Report of the U.S. Geographic Board.

FURTHER CHANGES OF NAMES IN PERSIA

We have been informed by the Foreign Office of the following further changes of names in Persia. Aq Qal'eh, 12 miles north of Asterabad, on the river Gurgan, is now Pahlevi Diz; 'Aliabad, 11 miles south-east of Barfrush, the present terminus of the North Persia railway from Bandar-i-Gaz, previously renamed Shahabad, is now 'Aliabad Shahi; Barfrush itself is now Babul; Dilman, or Dilmaqan, in the Salmas district of Azerbaijan, is now Shahpur; Fahrej in the province of Kerman, at the south end of the Dasht-i-Lut, is now Iran Shahr; Habibabad, on the Caspian, about 2 miles east of the river Chalas (now generally called Chalus), is now Deh-i-Nau; Harunabad, 30 miles south-west of Kermanshah, on the Baghdad road, is now Shahabad; Khabis, 40 miles east of Kerman town, is now Shah Dad; Qarasu, at the south-east corner of the Caspian, presumably near the mouth of the river of that name, is now Bandar Shah; Qumisheh, 50 miles south of Isfahan, on the Shiraz road, is now Shahriza, which appears to have hitherto been the name of a village with gardens 2 miles north of the town; Tun in Khurasan, on the Meshed-Kerman road, is now Firdaus; Urmia, Persian Urumiyeh, is now Rizaiyeh. We are also informed that the new port at the terminus of the southern railway on Khor Musa at the head of the Persian Gulf has been named Bandar Shahpur.

OBITUARY

PROFESSOR J. W. GREGORY

The Society has recently suffered a grievous loss through the death of John Walter Gregory, who was accidentally drowned by the capsize of a canoe in the Urubamba River near the Megantoni Falls in Northern Peru on June 2, at the age of sixty-eight. For nearly forty years he had been a Fellow of the Society and throughout that period had maintained close touch with it, contributing papers on his various journeys, reviewing books for the *Journal*, and speaking at meetings. His knowledge was encyclopaedic and his brain was so active that he was always able to stimulate discussion by a new point of view.

In 1887 he entered the Geological Department of the Natural History Museum and rapidly became known as an authority on Fossil Corals and Bryozoa. Five years later came his first chance of doing important geographical and geological work, for he was lent by the Museum as the scientific member of a large expedition sent out to explore the northern portion of what is now Kenya Colony. The expedition started up the Tana River, but owing to transport difficulties and internal dissension unfortunately broke down and was abandoned. Gregory however indomitably declined to be defeated; he returned to Mombasa and, finding sympathetic friends among the officers of the I.B.E.A. Co., with their help and at his own expense, fitted out a slender expedition to the interior. Everybody prophesied disaster, but persuasion was unavailing, and some six months later he safely returned with epoch-making scientific results; for he had solved the main features of the structure of the eastern half of the continent of Africa, and in addition had ascended to the snow-line of Mount Kenya. The hardships of the journey were great: it was ill provided, its leader was heavily infected with both malaria and dysentery, and it was only his indomitable will and enthusiasm that enabled him to win through. His account of this journey and the conclusions deduced therefrom were given to the Society and later appeared in a work entitled 'The Great Rift Valley,' published in 1896. One of the results of this journey to East Africa was a life-long interest in what may be termed the human geography of Africa; he became a friendly critic of our Colonial policy in Africa and devoted much consideration to the relationships of black and white in that Continent. In this connection reference is invited to his two books 'The Menace of Colour' (1925) and 'Human Migration and the Future' (1928). Upon his return from this early African journey he suffered much from its effects, but in 1896 as a health cure he accompanied Lord Conway (then Sir Martin Conway) in a strenuous journey across Spitsbergen; and, as he used to remark in a matter-of-fact way, "the Arctic killed all my tropical disease germs."

In 1901 he was appointed Professor of Geology at Melbourne, a post he held for about four years; during that time he firmly established himself as the leading authority in Australia on water supply and mining geology; he led an expedition into the waterless region around Lake Eyre and wrote an interesting work entitled 'The Dead Heart of Australia,' in which he embodied his views on the source of the artesian water of the central portion of that continent. Australia was however too remote for a man of his calibre, and about the end of 1904 he was appointed to the Chair of Geology at Glasgow, a post which he held for twenty-five years, proving a worthy successor to a distinguished line of great professors who have made Scottish geologists famous. Owing to his personality the Glasgow geology school eventually grew into one of the largest in the Empire, and many of his students now hold responsible posts in various parts of the world.

While at Glasgow, although a hard-worked man, he always seemed able to find time for distant journeys; he visited Cyrenaica in order to report whether that region was suitable for Jewish settlement, and made a trip to Portuguese West Africa on the same mission.

In 1917 he was appointed a member of the Government Commission charged to inquire into the working and organization of Calcutta University; this was a lengthy business and one to which he devoted much attention, but in some ways it was not the happiest experience of his life, and he felt obliged to write a minority report. From India he proceeded direct to Kenya and spent a few months there investigating some special problems, thus renewing his acquaintance with the country. He was greatly interested in the changes which had occurred after a gap of twenty-five years. In 1922 he and his son made an important journey into Chinese Tibet and brought back much valuable information regarding the tectonics of that region, which was duly published.

From 1928–1930 he was President of the Geological Society of London; during his tenure of that post he retired from his Glasgow professorship, left that city, and settled in Essex. At the end of 1931 he embarked on the trip which was fated to be his last. He had for a long time been intrigued by certain features of the structure of South America which he believed had not been fully elucidated, so he decided to attempt their solution. To what extent he succeeded is not at present known, and it is to be hoped that his notes may have been preserved and that they will be full enough for publication, for Gregory had the genius of throwing fresh light on any problem he attacked.

It is impossible here to chronicle all the achievements of such a crowded life. Only those who have been in close contact with him can realize his amazing industry, his powers of physical endurance, and his extraordinary memory. His range of knowledge was immense: primarily a great geologist, who will be remembered as the author of the tension theory of rift valley formation which of late years has been contested but by no means demolished, he also devoted much consideration to the genesis of ore deposits, to glaciology, and to the distribution of the continental masses, to mention only a few of the subjects upon which he concentrated. He looked upon the world as a whole, and his outlook knew no frontiers, for there were few countries which he had not visited; at the same time his great human sympathies kept the problems of humanity always before him. Of modest and unassuming bearing, full of kindness, and always ready to help a colleague with information, his passing leaves a gap which it is impossible to fill. The deepest sympathy is accorded to his devoted family.

C. W. H

Mr. A. V. Coverley-Price, *who was a member of the party, has written the following account of Professor Gregory's death:*

Professor Gregory, whom I was accompanying on his expedition to Peru, lost his life by drowning on June 2 last when the canoe in which we were travelling capsized in the Pongo de Mainiqui rapids of the Rio Urubamba. These rapids are situated about 7 miles north of the mouth of the Rio Paucartambo, known locally as the Rio Yavero, a tributary of the Rio Urubamba.

On Tuesday, May 31, three members of the expedition, the Professor, Miss McKinnon Wood, and I, arrived by canoe at the house of two traders, Señores Pereira and Landa, close to a small tributary of the Rio Urubamba named Maranquiato. Here we met the fourth member of the expedition, Mr. C. M. Tarnawiecki, a Peruvian mining engineer of Polish origin.

On the morning of June 1 last we left Maranquiato with two canoes and a small raft. The canoes were dug-out canoes of mahogany, about 40 feet long, 2½ feet wide, and 20 inches deep. Señor Landa decided to accompany us. The Professor, Miss Wood, Señor Landa, and I travelled in one canoe with a crew of six natives and some of the luggage. Mr. Tarnawiecki was in the other canoe with the rest of the luggage and a crew of six.

We made a bivouac that night on a mud flat covered with small boulders forming an island in the Rio Urubamba near the mouth of the Rio Yuyato. At the Pongo de Mainiqui the river narrows and passes for about 3 kilometres through a limestone gorge. There are bad rapids at frequent intervals over the 7 kilometres between the stream Saniriato and the point named Tonkini where the gorge ends. The rapids in the lower section of the Pongo de Mainiqui are known by the natives as the Megantoni rapids; they are particularly turbulent and the walls of the canyon at this point rise precipitously to an average height of about 50 feet. It is almost impossible to pass overland. The only inland route is the old Robledo trail, now obliterated in many places by landslides.

The exposures of rock in the Pongo are of particular geological interest, and contain many fossils. Professor Gregory expressed his desire to remain about four hours in this section, while a portage was made, in order that a good number of specimens might be collected.

On June 2 we left our camping ground a few minutes after eight o'clock. The two canoes entered the Pongo de Mainiqui and passed safely through a succession of bad rapids known as the Challaunancani, Chibugoni, and Megantoni. We then disembarked on the right bank and spent the time collecting fossils from the limestone close to the foaming river. Meanwhile the natives, under the supervision of Señor Landa, carried our luggage over the rocks—no easy task, for the rock in places was wet and slippery and sloped steeply to the water—and then prepared to lower the canoes, stern first, with the aid of ropes. The distance to the only suitable point for re-embarkation was not more than 300 or 400 yards; but the lower section of the rapids is very dangerous.

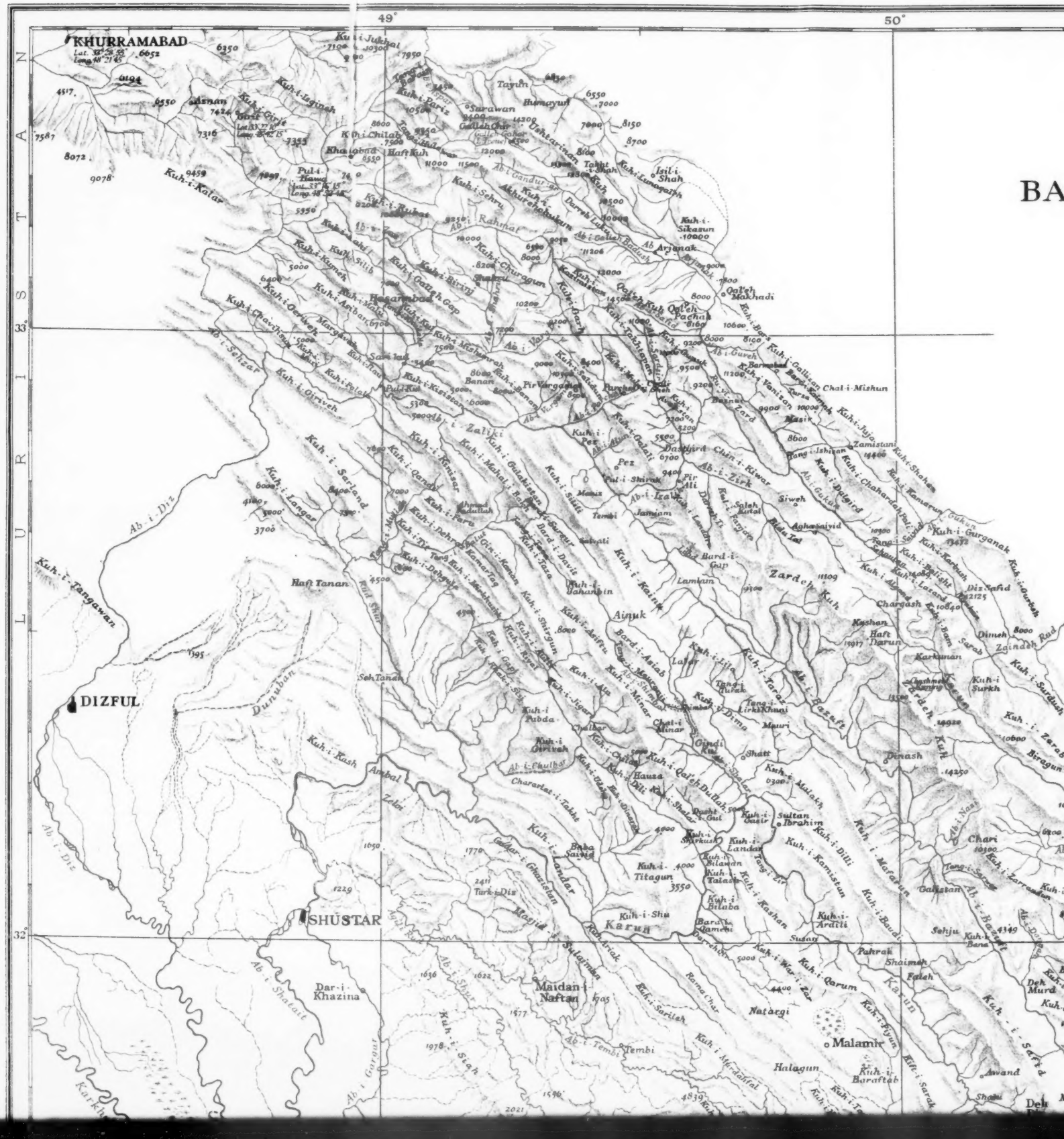
The natives, who are experts on the river, lowered the empty canoes, one at a time, with the aid of long ropes. Those who held the ropes clambered nimbly over the rocks above, while others using poles prevented the canoes being smashed against the rocks below. Just before reaching the embarkation point the first canoe was swung sideways by the violent rush of water leaping between the rocks. Struck by waves on all sides, it filled with water and sank to the gunnel. It was hauled to the shore with difficulty and baled out. The second canoe in its turn also began to fill, but was pulled to the shore just before it sank. After witnessing the swamping of the empty canoes, I fully realized that our passage through the remaining section of the Pongo would be dangerous.

The canoes were re-loaded and we took our places in them. Mr. Tarnawiecki's canoe shot past us and was beached, half full of water, 500 or 600 yards lower down at the point named Tonkini. Seeing that water was splashing freely into our canoe, I asked Señor Landa whether it would not be possible for us to climb over the rocks to a point farther downstream, to which the canoe might be lowered. But he told me that this could not be done; the walls of the canyon were so steep that there was no alternative but to pass through the rapids in the canoe.

As we pushed off from the bank the waves broke over the canoe, and by the time we had been guided with poles past the jutting rocks which threatened to smash the canoe, it was half full of water. Rapidly swept into midstream, the canoe filled in a few seconds. We remained sitting in it, although some of the baggage began to float, hoping that we would pass quickly downstream to a

point where it could be beached. The next moment however it had turned over and we were all thrown into the water.

There were not more than about 40 feet between me and the shore, but complex currents raced through the channel, and I was carried a considerable distance downstream before I was able to scramble out at the foot of some steep buttresses of limestone rising sheer from the water. Where I landed, I could see nothing downstream, so I clambered up the rock to a perch about 50 feet above the water whence I could obtain a better view. The climb was not easy, for wet limestone is slippery, I was drenched to the skin, and the crêpe-rubber soles of my worn canvas shoes were nearly torn off. I had to use both hands and feet. While I was clinging to the rock to survey the scene, Miss Wood appeared on another buttress below me, a few yards farther downstream. From our precarious perch we could see the canoe, bottom uppermost, in a small bay, and the men who had clung to it pulling themselves on to any foothold they could find at the base of a sheer wall of rock. The surface of the turbulent water showed at least three or four whirlpools shifting amidst the complex currents, and several pieces of baggage were floating upstream or downstream, according to the current which carried them. Professor Gregory was clinging with both hands to a floating package, moving upstream on the outer edge of a whirlpool. For a moment I thought that he was endeavouring to save a piece of his luggage by pushing it to the shore, and it did not at first occur to me that he might be in difficulty. He then turned out into midstream with the current and passed down towards the opposite bank. When I saw that he was drifting with the current and making no attempt to swim or paddle with his hands, I realized that he must be in difficulty, and I at once began to climb down to the water. By the time I reached it, the Professor was 100 yards away, and contrary currents whirled between me and him. I tried in vain to reach Señor Landa and the natives, and I shouted to them; but the noise of the rapids drowned my voice. By this time the bag to which Professor Gregory was clinging had swung round, and he was hidden from my view behind it. I did not see him again.


49°
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KHURRAMABAD
DIZFUL
SHUSTAR
Kuh-i-Kalar
Kuh-i-Izginah
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Haft Kuh
Kuh-i-Sehru
Kuh-i-Churagun
Kuh-i-Gaugeh Gap
Kuh-i-Kuneh
Kuh-i-Stilb
Kuh-i-Arbar
Kuh-i-Mishkhrah
Kuh-i-Banan
Kuh-i-Kiristan
Kuh-i-Qanat
Kuh-i-Sarband
Kuh-i-Langar
Kuh-i-Tangawan
Kuh-i-Dehgerd
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Kuh-i-Titagun
Kuh-i-Landar
Kuh-i-Karun
Kuh-i-Aqili
Kuh-i-Sulaiman
Kuh-i-Sarileh
Kuh-i-Qarum
Kuh-i-Kamistun
Kuh-i-Marsun
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Kuh-i-Shu
Kuh-i-Shurkush
Kuh-i-Qaleh Dukhtar
Kuh-i-Qasir
Kuh-i-Malakh
Kuh-i-Shalar
Kuh-i-Olivesh
Kuh-i-Chulbar
Kuh-i-Jigar
Kuh-i-Pubda
Kuh-i-Asiftu
Kuh-i-Aqsh
Kuh-i-Shirgun
Kuh-i-Jahanbin
Kuh-i-Kaish
Kuh-i-Lila
Kuh-i-Taraz
Kuh-i-Dima
Kuh-i-Surkh
Kuh-i-Zard
Kuh-i-Gurganak
Kuh-i-Karkun
Kuh-i-Surdukh
Kuh-i-Zardeh
Kuh-i-Biragun
Kuh-i-Dinash
Kuh-i-Malakh
Kuh-i-Baudi
Kuh-i-Sarta
Kuh-i-Deh Murd
Kuh-i-Pazuft
Kuh-i-Qaleh Pachak
Kuh-i-Qaleh Makhadi
Kuh-i-Sikasun
Kuh-i-Isil-i-Shah
Kuh-i-Takht-i-Shah
Kuh-i-Akhurchehsurkh
Kuh-i-Darreh Lukh
Kuh-i-Gallian Beduish
Kuh-i-Vanitan
Kuh-i-Jujin
Kuh-i-Chaharduli
Kuh-i-Kanarun
Kuh-i-Shahan
Kuh-i-Dalgird
Kuh-i-Ishkan
Kuh-i-Gukan
Kuh-i-Balisht
Kuh-i-Lazang
Kuh-i-Karkun
Kuh-i-Parkeh
Kuh-i-Zaindeh Rud
Kuh-i-Zard
Kuh-i-Pez
Kuh-i-Gaduli
Kuh-i-Dasht-i-Kuh
Kuh-i-Pahlu
Kuh-i-Qirveh
Kuh-i-Sefear
Kuh-i-Chaghsuk
Kuh-i-Qeshlak
Kuh-i-Margdar
Kuh-i-Hasu
Kuh-i-Mahal-i-Rash
Kuh-i-Gulabestan
Kuh-i-Shitil
Kuh-i-Tasa
Kuh-i-Davit
Kuh-i-Gisi-i-Kanan
Kuh-i-Kamarteg
Kuh-i-Mushkhuk
Kuh-i-Rivat
Kuh-i-Gasf
Kuh-i-Sisk
Kuh-i-Alta
Kuh-i-Minar
Kuh-i-Simbar
Kuh-i-Tirkhi Khuni
Kuh-i-Qaleh Dukhtar

51°

S. W. PERSIA

Map of the

BAKHTIARI COUNTRY

To accompany a paper

by

J. V. HARRISON, D.Sc., F.G.S.

33°

Scale 1:800000

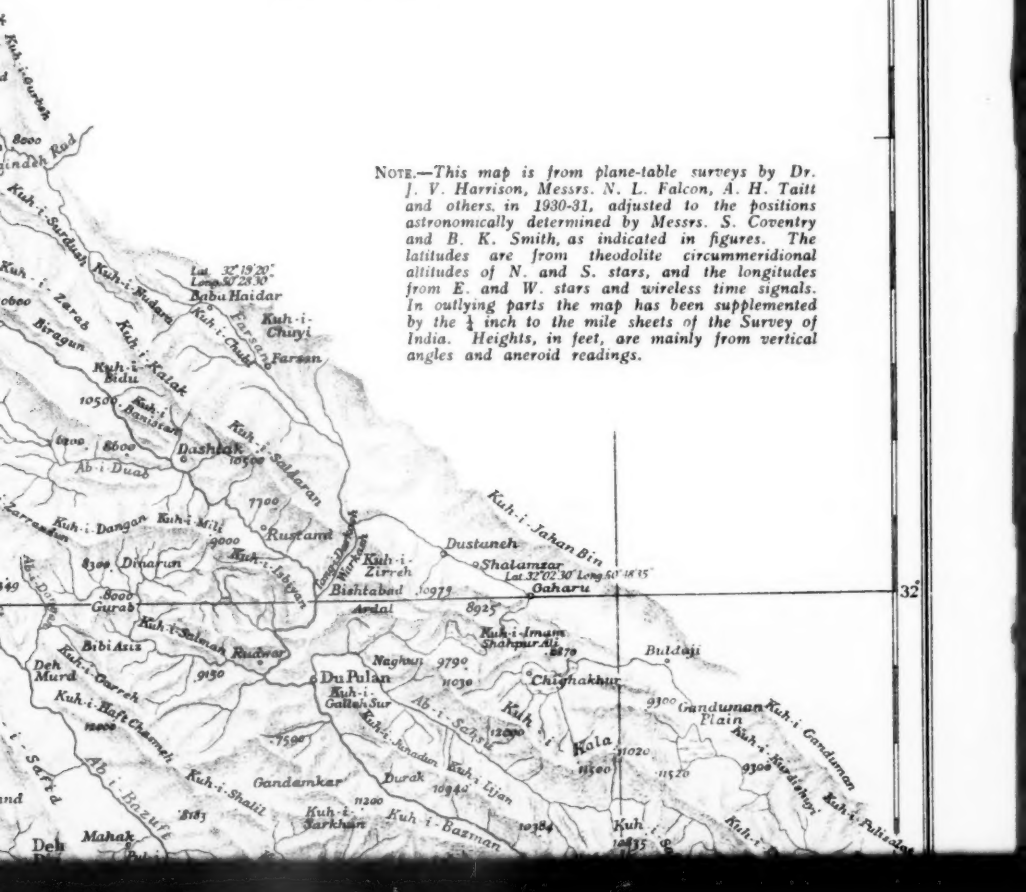
10 0 10 20 30

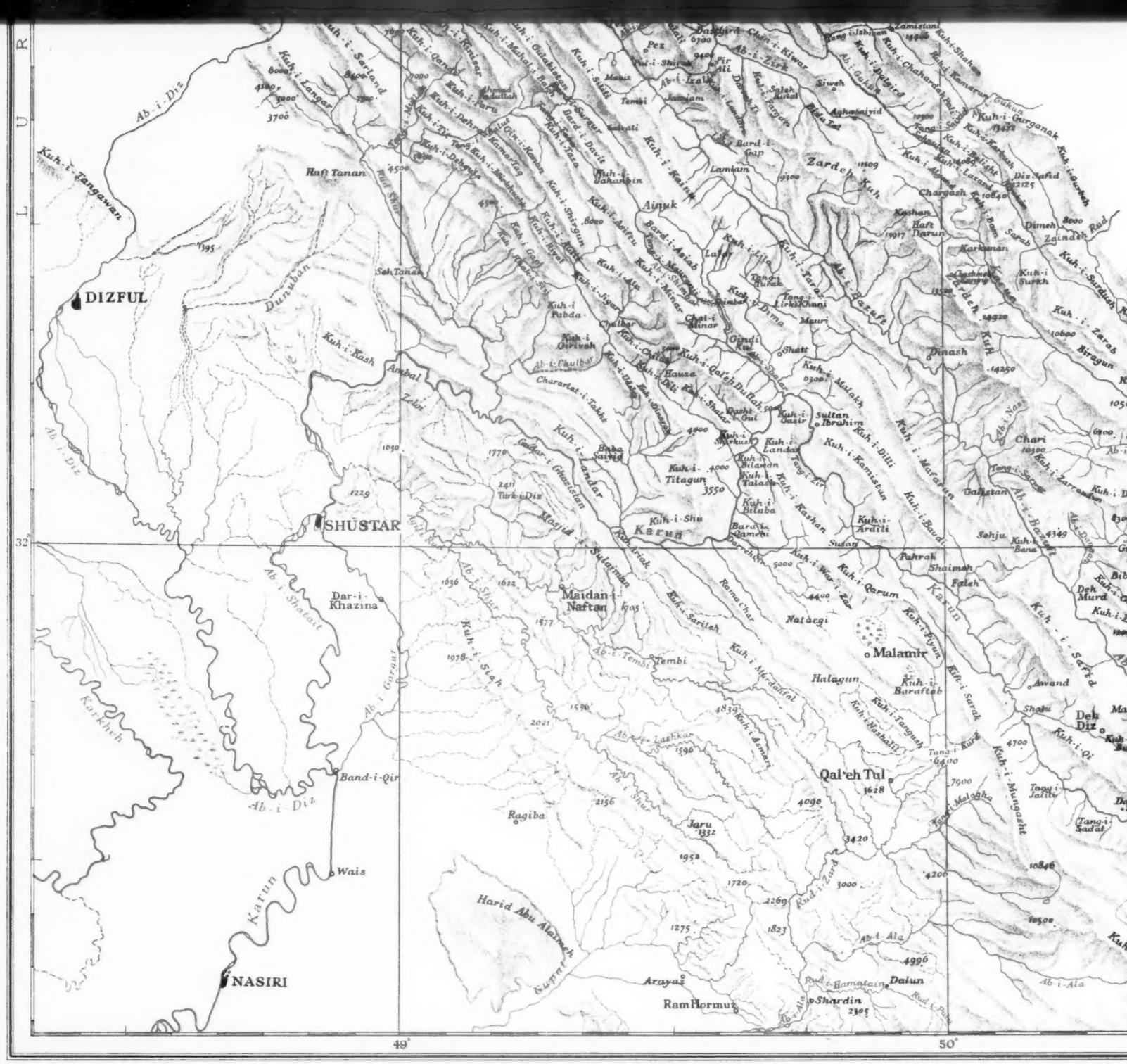
Statute Miles

Glossary

Ab	*Water*
Chashmeh	*Spring*
Pul	*Bridge*
Kuh	*Mountain*
Rud	*River*
Tang	*Defile*

NOTE.—*This map is from plane-table surveys by Dr. J. V. Harrison, Messrs. N. L. Falcon, A. H. Taitt and others, in 1930-31, adjusted to the positions astronomically determined by Messrs. S. Coventry and B. K. Smith, as indicated in figures. The latitudes are from theodolite circummeridional altitudes of N. and S. stars, and the longitudes from E. and W. stars and wireless time signals. In outlying parts the map has been supplemented by the ¼ inch to the mile sheets of the Survey of India. Heights, in feet, are mainly from vertical angles and aneroid readings.*





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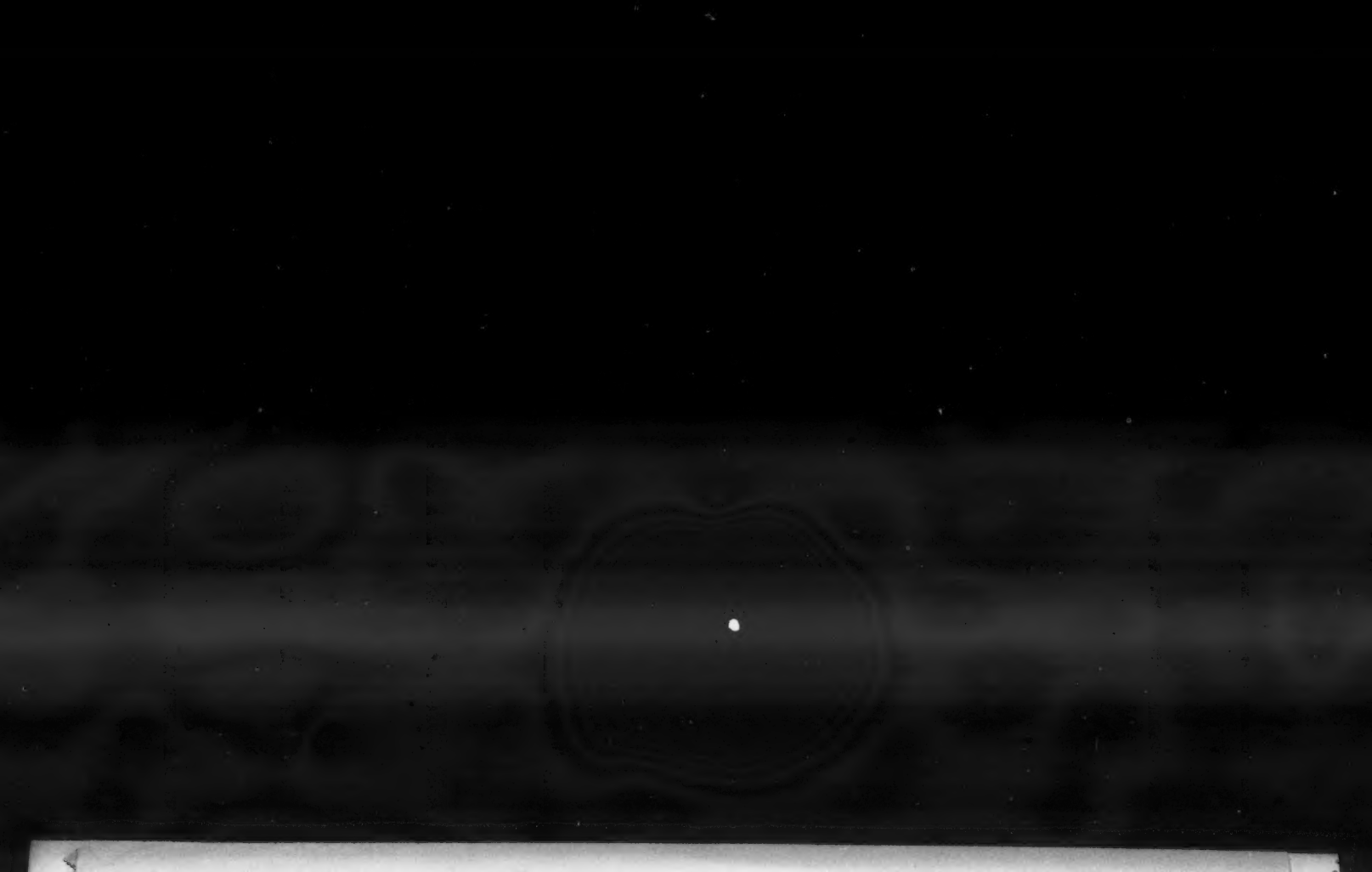
BAKHTIARI COUNTRY
Harrison